THE

GEOLOGICAL MAGAZINE.

NEW SERIES. DECADE V. VOL. VII.

No. XI.—NOVEMBER, 1910.

ORIGINAL ARTICLES.

I.—Notes on new or imperfectly known Chalk Polyzoa.

By R. M. Brydone, F.G.S.

(PLATE XXXVI.)

(*Continued from the September Number, p.* 392.)

Steginopora denticulata, nov. Pl. XXXVI, Figs. 1–3.

Zoarium always unilaminate, nearly always adherent.

Zoœcia broad, length ·65–·8 mm., breadth ·45–·55 mm., aperture primarily semicircular but tending to quadrangular by thickening of the upper lip, and with a semicircular collar, the two ends of which are expanded into large perforated spine bases: the arched front wall springs from the inside of the side walls and is pierced along its edge by a row of large pores, and at a short distance inside this row by a row of smaller pores in fairly close correspondence with the outer row; the centre of the front wall is pierced by a very variable number of fine pores, which sometimes give clear indications of a third row corresponding to the two outer ones; the zoœcia always have common side walls of considerable width; in immature stages (Fig. 1) the front walls rise high above the side walls, and small beak-shaped avicularia are scattered irregularly between them; in a further stage of development (Fig. 2) the side walls are greatly thickened and raised above the front walls, absorbing the avicularia, and the perforated spine bases at the corners of the aperture grow inwards until they meet, and are fused into a stout bar across the aperture, so qualifying the species for admission to the Steginoporidæ; in the stage of maximum development (Fig. 3) the bar develops a stout denticle in the middle of the lower edge.

Oœcia not observed.

Rare in the zone of *M. cor-anguinum* at Gravesend, Broadstairs, Kingsgate Bay, and Leaves Green, near Bromley.

Steginopora Gravensis, nov. Pl. XXXVI, Figs. 4–5.

Zoarium unilaminate, adherent.

Zoœcia long and narrow, average length ·65 mm., breadth ·35–·4 mm.; with very broad common side walls, between which is deeply sunk the flat front wall pierced by numerous transverse paired slits, which

only begin to radiate quite close to the foot of the zoarium, and are so fine as to be rarely well visible; aperture semi-oval, with a tiny denticle in the middle of the lower lip and a thick raised upper lip often bearing three or four perforated tubercles; the corners of the aperture are overhung by two stout perforated spine bases projecting from the upper lip, which often fill up and unite to form an arch across the lower part of the aperture: small perforated tubercles are scattered irregularly and sparingly on the side walls; these features are often very feebly marked.

Oœcia not observed.

Avicularia may be represented by the perforated tubercles.

Very rare in the zone of *M. cor-anguinum* at Gravesend.

It will be observed that the two foregoing species represent a very early stage in the evolution of the Steginoporidæ; it is curious that no species of this family is yet known to occur at any later horizon in the English Chalk.

MEMBRANIPORELLA FALLAX, nov. Pl. XXXVI, Figs. 6–8.

Zoarium unilaminate, adherent.

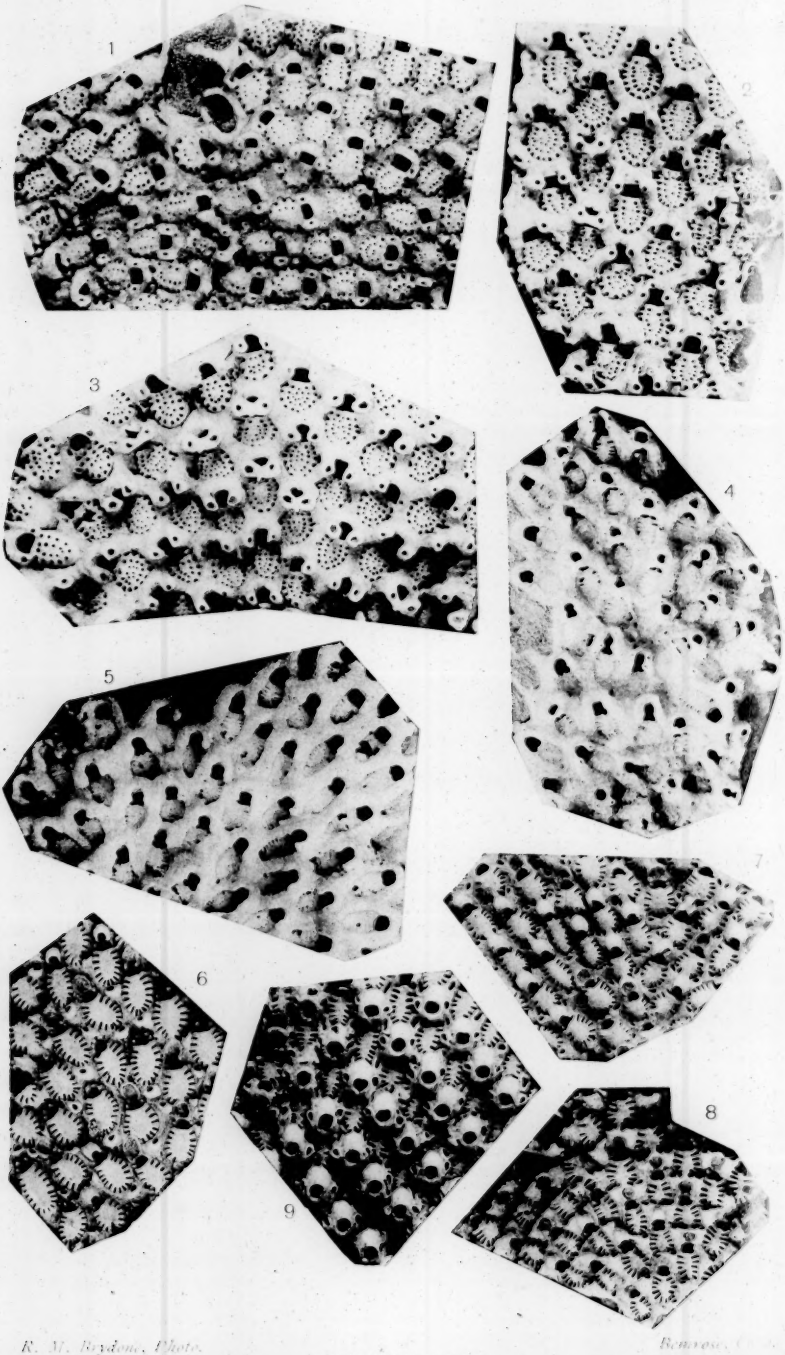
Zoœcia oval, average length ·7–·8 mm., breadth ·35–·4 mm.; the arched front wall rests on the side walls, and is pierced by seven or eight paired diverging slits extending from the edge about half-way toward the middle line: aperture semicircular, showing in ordinary specimens (Fig. 6) two imperforate tubercles on either side when there is no oœcium, the upper pair of which are picked up by and form the starting-point of the oœcium when one is formed, as is usually the case; the lower lip of the aperture often bears a median denticle of very variable size. Such specimens give a delusive appearance of organization similar to that of *Cribrilina fureifera*, but in the upper right-hand corner of Fig. 7 there may be observed a zoœcium which shows that what appear to be a pair (the lower pair) of tubercles and a median denticle are in fact the scanty remains of the true lower lip of the aperture, which has almost invariably been broken away: in another zoœcium in the same figure it is preserved on one side only.

Oœcia long and narrow, very generally present; they often appear to throw out a sort of causeway leading on to the front wall of the zoœcium (if any) immediately succeeding the same line.

Avicularia beak-shaped, small, but very deep, with a slender bar, which is rarely preserved, across the aperture; generally lying more or less on their sides and with a strong tendency to occur singly or in pairs with their beaks directed downwards or inwards at the head of the zoœcium. Fig. 8 shows a specimen of exceptional regularity in this respect.

The species is not uncommon in the zone of *M. cor-anguinum* at Gravesend, and a dwarfed form has been found at the top of the zone of *Marsupites* at two places in Hants. It comes nearest to the form figured by Novak[1] as *Lepralia pediculus*, Rss., but is easily

[1] Novak, Denkschr. d. k.k. Ak. d. Wiss. zu Wien, Math.-Naturw. Cl., Bd. xxxvii, p. 93, pl. i, fig. 12.



R. M. Reydon, Photo. CHALK POLYZOA. Benrose, Co.

distinguished from it and still more easily distinguished from Reuss' original figure.[1]

MEMBRANIPORELLA PUSTULOSA, nov. Pl. XXXVI, Fig. 9.

Zoarium unilaminate, adherent.

Zoœcia long and slender, average length ·7–·8 mm., breadth ·3–·4 mm.; the aperture is enclosed by a raised ring which is either truly circular or slightly broader than long, and merges in the upper part with the oœcium, much as in *M. castrum*; the side walls are thin, exsert, and quite separate from those of the adjoining zoœcia; the front walls are formed by a broad backbone united to the side walls by about seven ribs springing from the inside of the side walls and with well-marked and sometimes considerable spaces between them.

Oœcia globose, without external aperture, and cutting into the front wall of the succeeding zoœcium; they are almost invariably present.

Avicularia mandibular, thin-walled, small but wide; in normal zoœcia there is always one on either side of the aperture with the beak pointing downwards, and others occur irregularly along the side walls.

Occurs in all zones from that of *M. cor-anguinum* to that of *B. mucronata*.

This species is closely related to *Cellepora galeata*, Hag.,[2] in which species, however, the apertural ring is distinctly longer than broad, the spaces between the ribs are very short and do not reach the side walls, there is only a very slight swelling to suggest an oœcium, and the side walls are broad and common.

EXPLANATION OF PLATE XXXVI.

(All figures × 12 diams.)

FIG. 1. *Steginopora denticulata*. Gravesend.
,, 2. Ditto. Broadstairs.
,, 3. Ditto. Gravesend (another specimen).
,, 4. *Steginopora Gravensis*. Gravesend.
,, 5. Ditto. Gravesend (another specimen).
,, 6. *Membraniporella fallax*. Gravesend.
,, 7. Ditto. Gravesend (another specimen).
,, 8. Ditto. West Tisted, Hants. A dwarfed form.
,, 9. *Membraniporella pustulosa*. Gravesend.

II.—A FRAGMENT OF A FOSSIL IN A CHALK FLINT PEBBLE FROM THE SHERRINGHAM BEACH, NORFOLK.

BY HENRY WOODWARD, LL.D., F.R.S.

THE difficulties which the palæontologist encounters in attempting the interpretation of fossil organic remains are numerous, especially when compared with the task of the zoologist in the study of recent forms. In a fossil, for instance, the soft parts of the animal are wanting, while the endo- or exoskeleton is often remarkably

[1] *Das Elbthalgebirge in Sachsen*, pt. ii, p. 129, pl. xxiv, fig. 16.
[2] In Geinitz, *Grundriss d. Versteinerungskunde*, p. 613, pl. xxiii*b*, fig. 34.

dissimilar from that of its nearest living allies. Furthermore, the object he has to deal with has undergone mineralization, more or less completely, so that its appearance is greatly altered. But most frequently the object placed before him is only a fragment of the hard part of some animal which he is nevertheless called upon to identify at once.

Here is a case in point: my friend Mr. W. H. Paterson requested me to name a fragmentary fossil embedded in a waterworn flint from the Chalk, picked up by Mrs. Paterson some years since on the beach at Sherringham, Norfolk. The structure (whatever it might be) occupied only a part of the pebble (Fig. 1), and was also partially exposed on the reverse side (Fig. 2). It was certainly not related to the ordinary forms of inorganic markings known as 'banded flints', which frequently occur as flint pebbles on our shores, and were at one time believed by Dr. Bowerbank and others to be the remains of fossil sponges. My brother, the late Dr. S. P. Woodward, described a number of these in a paper in the Geological Magazine (1864, Vol. I, pp. 145–9, Plates VII and VIII). The banded structure in

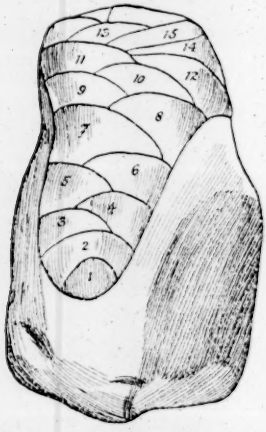


Fig. 1.

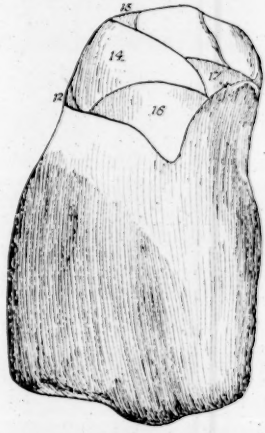


Fig. 2.

Fig. 1, obverse; Fig. 2, reverse side of waterworn flint pebble from the beach at Sherringham, Norfolk. In the collection of W. H. Paterson, Esq.

these flints is certainly due in many cases to deposition (op. cit., Pl. VI, Fig. 4), but in other instances the banding, if not caused by, is accentuated by the introduction within the flints of mineral colouring matter, carried in solution by water permeating the flint along lines of least resistance; for even flint contains much water interstitially within its pores, which escapes by evaporation when flints lie exposed upon the surface. Instead of the transverse lines seen in ordinary banded flints, the surface of the Sherringham pebble displays about fifteen imbricated, scale-like markings upon its front or obverse (Fig. 1) side, and two or three additional ones (evidently part

of the same structure exposed on the reverse side) near the top end of the flint (Fig. 2). I assume, for description, that the convex edge of the scale-like markings is the *upper margin* as shown in the drawing.

Measurement of scales from exposed base to summit.

From base,	scale No. 1	is	8 mm.	broad by	5 mm.	high.
	2		15	,, ,,	5	,,
	3		12	,, ,,	5	,,
	4		14	,, ,,	7	,,
	5		13	,, ,,	13	,,
	6		16	,, ,,	7	,,
	7		23	,, ,,	9	,,
	8		17	,, ,,	8	,,
	9		15	,, ,,	5	,,
	10		15	,, ,,	5	,,
	11		17	,, ,,	5	,,
	12		17	,, ,,	4	,,
	13		20	,, ,,	5	,,
	14		43	,, ,,	10	,,
To summit	15		18	,, ,,	4	,,

Scales on reverse side exposed near the summit of the flint.

Nos. 12 and 14 both wrap around the edge of the flint, and appear on the reverse side also, intercalated with Nos. 16 and 17.

	No. 16	is	20 mm.	broad by	10 mm.	high.
	17		10	,, ,,	5	,,

The upper portion is obscured, being, like the rest of the pebble, much worn down by rolling and attrition. The lower part of the pebble is composed of a dark amorphous flint which merges into a lighter shade near the scale-like markings.

If we compare the specimen before us with the rare remains of Coniferous cones met with in a fossil state, I cannot remember to have seen a silicified Cretaceous example, nor one in which the carbonaceous matter was not preserved and showed the separate bracts visibly overlapping one another from the apex to the base. This is not the case in the fossil in flint we are considering.

I suggested to Dr. Arthur Smith Woodward that possibly the specimen might represent a fragment of a fossil fish, but he pointed out to me that the scale-like markings are not uniform, nor are they arranged symmetrically, also that they have been worn away to one level, and have no structure visible.

I compared the pebble with a fish-coprolite from the Chalk, but although these bodies have an arrangement in layers the phosphatic material composing them is always preserved, and they have never in my experience been met with silicified or enclosed in a chalk flint.

I submitted the rolled flint to Dr. F. A. Bather, but after a careful examination he wrote on the label the following note: "No one in the Geological Department considers the markings organic. The bands have no appreciable thickness. (F. A. B.)"

I wrote to my friend Dr. Hinde to ask whether the specimen might possibly be attributable to a fossil sponge, chalk sponges being most abundantly met with in that formation enclosed in flints. He replied that the markings did not resemble those of any sponge with which he was acquainted.

I then placed the specimen before me and meditated upon it from time to time, a process which I have frequently found tended to illumination. I recalled the well-known fact that there are quite a number of corals and mollusca which build up body-chambers needlessly large for their personal accommodation, and then proceed to reduce them again by shutting off a portion from time to time by secreting a shelly partition or septum across the lower part of the living-chamber.[1] Such energy in shell-growth has been attributed to various causes:—(1) There may be a necessity for the animal to grow upwards to prevent its being immersed in sand or other sediment which threatened to overwhelm the sedentary mollusc or coral. (2) Professor H. G. Seeley suggested that more rapid shell-growth in Cephalopod shells was due to a periodic necessity to provide a larger body-chamber to accommodate the gravid ovisacs of the female prior to the extrusion of the ova. (3) Professor Owen suggested that the mantle of the mollusc, which secretes the shell, deposited new matter to its outer border more rapidly than it does to the umbonal or hinge-area.

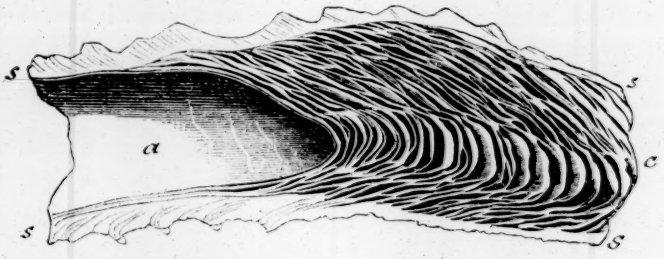


Fig. 3. Section of a portion of the shell of a long-beaked oyster, *Ostrea cornucopiæ*, showing interior (umbonal) portion of valve filled up by a series of extremely thin lamellæ (*c*), quite distinct from the compact shell-wall (*s*, *s*); *a*, part of the body-chamber occupied by the animal. (From Dr. S. P. Woodward's *Manual of the Mollusca*, 1851–6, 1st ed., p. 281, fig. 192.)

This addition to the margin of the shell compels the animal to advance its body and the attachment of its shell-muscles also, in order to follow this forward or upward growth of the shell. To obviate the excess of space thus acquired the lining-mantle of the animal partitions off the lower portion of its body-chamber by secreting a series of shelly layers, very regular in Cephalopod shells, such as the Nautilus and Ammonite, but more or less irregular in the other Mollusca, such as the Water Spondylus, the Exogyra, and some Hippurites and Oysters. (Fig. 3.)

[1] See a series of illustrated articles "On the Form, Growth, and Construction of Shells" by the late Dr. S. P. Woodward, edited by H. Woodward, in the *Intellectual Observer*, vol. x, pp. 241–53, November, 1866; vol. xi. pp. 18–30, 161–72, 1867. See also Henry Woodward, "The Pearly Nautilus, Cuttle-fish, and their Allies": *Student and Intellectual Observer*, vol. iv, pp. 1–14; pt. ii. pp. 241–9, 1870. "On the Structure of the Shell of the Pearly Nautilus," 1870, Brit. Assoc. Sect., Liverpool Meeting, p. 128. "On the Structure of Camerated Shells": *Popular Science Review*, vol. xi, pp. 113–20, pl. lxxxii, 1872.

In some corals the lower portion of the corallite chamber may be shut off by nearly regular simple horizontal septa, as in *Favosites*, or the interior may be filled by irregularly formed meniscus-like cells filling up the central cavity below each polype, as seen in the Zoantharia Rugosa. In *Ostrea cornucopiæ* (Fig. 3), and in a species of oyster from the Tertiary of Cerigo, Ionian Isles, in Mr. W. J. Hamilton's Collection (Brit. Mus. 34033), a large portion of the interior of the shell is shut off by numerous irregular septa forming, as in *Spondylus*, water-cavities within the shell. These inner septal shell-layers are *quite distinct* from the *outer shell-wall*, they are much less compact, the lamellæ are extremely thin, and they are often dissolved out entirely in the fossil forms.

In those singular molluscs the Rudistes we have forms like *Hippurites organisans*, Montf., in which a portion of the lower deep valve is partitioned off, like an *Orthoceras*, by a succession of almost regular septa, the intervening spaces forming water-chambers (Zittel, *Palæont.*, p. 282, fig. 632, 1895).

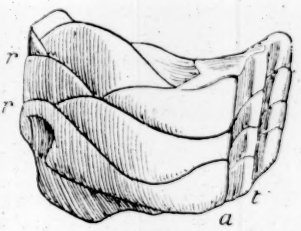


Fig. 4.

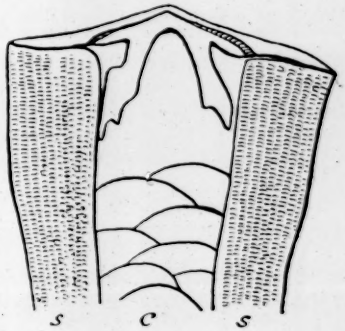


Fig. 5.

Fig. 4. Part of the internal *mould* taken from the interior of a shell of *Radiolites Mortoni*, Mantell (reduced), representing some of the water-chambers of the original shell, perforated by cliona. *r*, *r*, joints produced by the decomposition of the septa; *a*, furrows produced by adductor ridges; *t*, furrows produced by the dental ridges. From S. P. Woodward's article in Q.J.G.S., vol. xi, pl. v, fig. 2, 1855.

Fig. 5. Diagrammatic vertical section through shell of *Radiolites*, showing *s*, *s*, the outer shell-wall composed of prismatic cellular structure, the prisms being vertical to the shell-laminæ and minutely subdivided. *c*, section of the inner layer composed of transverse lamellæ, which are extremely thin, and are separated by intervals, like the water-chambers of *Spondylus*, and the similar spaces in the umbonal cavity of the long-beaked oysters. (See Fig. 3 *supra*; compare also with Fig. 1.)

In the British Cretaceous species *Sphærulites* (*Radiolites*) *Mortoni* the outer shell-wall is very thick and consists of dense prismatic cellular structure, like the recent *Pinna*. The lower central part of the valve has been shut off from time to time by a series of somewhat irregular meniscus-like septa, deposited by the mantle and built up in succession one upon another. In a specimen described by

Dr. S. P. Woodward in his classical paper "On the Structure and Affinities of the Hippuritidæ" (Quart. Journ. Geol. Soc., vol. xi. pp. 40–61, pl. v. figs. 1, 2, 1855), and preserved in the British Museum (Nat. Hist., No. 38219), obtained from the *Micraster cor-anguinum* zone of the Chalk at Rosherville, Gravesend, the internal chambers have been filled up solid and the extremely thin, shelly septa afterwards dissolved away, leaving only an internal mould composed of very hard chalk representing some of the chambers of the original shell (see Fig. 4). The shelly septa, always very thin and fragile, are commonly entirely dissolved out, or, as in this instance, replaced by a mould of chalk or flint, the shells of many *Radiolites* being more or less converted into or embedded in flint, as is also the case with the shells of *Inoceramus* from the Chalk.

Here, then, I think we have succeeded in finding a solution for the exceedingly puzzling rolled fossil in flint from the Sherringham Beach, and I feel justified in considering it to be the waterworn fragment of the chambered portion of the shell of a Radiolite, and most probably of *R. Mortoni*, replaced by silica. The outer prismatic cellular shell-wall in which this chambered portion was originally enclosed (see Fig. 5) has entirely disappeared, and the only evidence left is a relic of the mould in flint, of the chambers of which we see only the thin edges as they pass inwards to form in succession the series of transverse floors of what had been at one time a part of the body-chamber of the animal.

III.—The Residual Earths of British Guiana commonly termed 'Laterite'.

By Professor J. B. Harrison, C.M.G., M.A., F.G.S., F.I.C., assisted by K. D. Reid, Assistant Analyst British Guiana.

(*Continued from the October Number, p.* 452.)

THE Christianburg and Akyma deposits afford excellent examples of the highly aluminous or bauxitic type of laterite formation. They here occur as parts of a residuary deposit derived from the decomposition in situ of an igneous rock, probably a porphyrite or a tuff, an almost pure quartz-sand, and masses of bauxite containing in the more aluminous varieties from 92·6 to 94·4 per cent. of the hydrates of alumina and in the ferruginous ones 64·6 per cent. of the hydrates of alumina with about 24 per cent. of the oxides and hydrates of iron.

The Christianburg and Akyma deposits illustrate excellently the extreme of the formation of laterite, where the igneous rock, in place of weathering to a mixture of quartz, of kaolinite, of bauxite, and of the oxides and hydrates of iron, changes almost completely to quartz and to hydrates of alumina and the oxides and hydrates of iron. No explanation of the extreme intensity of the lateritic action in the Christianburg–Akyma district is at present obtainable. But as it is proposed to work the deposits I may be able to obtain further information when clean sections of them are available.

The foregoing examples represent the types of the residual deposits in situ in British Guiana, which I have regarded as and termed laterite. The concretionary masses in various parts of them range from ironstones with in round figures 93 per cent. of iron-ores and with less than 2 per cent. of aluminium hydrate to bauxites with less than 2 per cent. of iron-ores and with over 94 per cent. of aluminium hydrate. But the main bulk of the residual deposits in situ correspond to those which G. C. Du Bois in his monograph termed "Eluviale Laterite (primäre Laterite)", or "Kieselsäurereiche Laterite".

They are essentially buff, ochreous, red-brown or chocolate-coloured, ferruginous, more or less siliceous, clays and earths; and consist of mixtures in various proportion of angular quartz-sand and siliceous grit derived in part from quartz originally present in the rock of which they are products and in part secondarily from the decomposition of the felspars; of kaolinite, of bauxite, and of limonite, or other more or less hydrated oxides of iron, derived from the decomposition, hydration, and oxidation of the constituents of the felspars and of the ferro-magnesian minerals.

The mean proximate composition of the British Guiana lateritic earths which I have examined is in round figures:—

Table X.

Quartz	24
Iron-ores (including pisolites)	32
Kaolin, Sericite, and other felspathic debris, etc. .	24
Bauxite	20
	100

The earths I quoted as examples of the lateritic earths in my work on the Geology of the Gold-fields of British Guiana by weathering, detrition, washing, and re-arrangement of their proximate constituents could give rise to deposits consisting mainly of quartz-sand and of more or less bauxitic masses. For instance, the Tumatumari earths, if separated by natural elutriation, would give rise to a quartz-sand, say with 90 per cent. of quartz, and to bauxite with 63 per cent. of aluminium hydrate and 20 per cent. of iron-ores.

Whilst in the examples discussed there is no difficulty in tracing the silica set free during the decomposition of the rock into the form of masses of quartz as at Issorora, or into that of quartz-sand as in the earths from Tumatumari, Omai, Mazaruni, and Christianburg–Akyma, there are other cases in which little of the silica remains through the mass of the laterite. In some of these the ferruginous or aluminous lateritic earths are traversed by numerous thin veins of secondary quartz which intersect one another in all directions. These quartz-veins, which towards the surface of the laterite are not infrequently auriferous to paying extents or to even well-marked degrees, lessen in their contents of gold and tend to become barren when followed to a depth where they gradually thin completely out before reaching the less altered layers which are just above the undecomposed rock. In other places, as I have described elsewhere, the silica has segregated out in the form of lenticular masses not uncommonly described as 'quartz-reefs'.

Among places where the origin of the auriferous veins and masses of secondary quartz which occur in the laterite of the Guianas has been discussed, I may mention p. 41 of *Guide Pratique pour la recherche et l'exploitation de l'or en Guyane Française* by M. E. D. Levat (1898), pp. 21 and 22 of G. C. Du Bois' above quoted work on the Surinam laterite (1903), pp. 11 and 12 of the *Geology of the North-Western District of British Guiana* by H. I. Perkins and myself (1897), pp. 208 and 209 of the *Geology of the Gold-fields of British Guiana* (1908), and pp. 28 and 29 of *Goudindustrie in Suriname* by E. Middelberg (1908).

The attention of the technical geologists and the mining experts who have personally studied on the spot the residuary lateritic formations of the Guianas has necessarily been more attracted to the occurrence and nature of the secondary veins of auriferous quartz and to the gold disseminated in them than to the, from their point of view, very subordinate question of the presence or not of free aluminium hydroxide in the earths.

Decomposed Granites, Kaolins, or Pipe-clays.—The following are analyses of a granite and of a hornblende granitite, and of the products of their decomposition by weathering in situ, and of similar products of a granite, and of an aplite of which the compositions are not known:—

Table XI.

	Mazaruni.		Mahdia.		San San Kopai.	Orealla.
	Mazaruni River.		Potaro River.		Upper Mazaruni River.	Couranlyne River.
	Granite.	Pipe-clay	Hornblende Granitite.	Pipe-clay	Pipe-clay from Granite.	Pipe-clay from Aplite.
Quartz	36·60	38·70	29·50	38·15	48·32	6·69
Colloid Silica		1·60		·43	1·40	3·75
Combined Silica	37·21	27·68	38·70	25·25	23·08	42·44
Aluminium Oxide	13·93	19·82	15·83	24·60	17·67	33·02
Iron Peroxide	0·93	2·05	2·86	2·67	1·56	1·36
Iron Protoxide	0·46		0·51			
Magnesium Oxide	0·72	·11	2·14	·39	·22	·61
Calcium Oxide	0·88	nil	3·49	·10	·07	·02
Sodium Oxide	2·80	·39	3·07	nil	·36	·52
Potassium Oxide	4·81	·50	2·88	·41	·33	·17
Water	0·74	8·52	0·50	6·92	6·20	11·35
Titanium Oxide	0·62	·85	0·46	1·01	1	·01
Phosphoric Anhydride	0·06	·01	0·01	nil		nil
Manganese Oxide	0·24	trace	0·08	nil	trace	nil
	100	100·23	100·03	99·93	100·21	99·94

Their mineralogical compositions are shown as follows:—

TABLE XII.

	Mazaruni.		Mahdia.		San San Kopai.	Orealla.
	Mazaruni River.		Potaro River.		Upper Mazaruni River.	Couranlyne River.
	Granite.	Pipe-clay	Hornblende Granite.	Pipe-clay	Pipe-clay from Granite.	Pipe-clay from Aplite.
Quartz	36·6	38·7	29·5	38·1	48·3	6·7
Colloid Silica		1·6		·4	1·4	3·8
Orthoclase	20·6	2·9	15·5	2·4	1·9	1
Plagioclase	27·1	3·4	37·5	·5	3·4	4·6
Mica	13·3		3·3			
Hornblende			12·7			
Magnetite	1·1					
Limonite		·8		1·8	·8	1·6
Ilmenite	·3	1·6		1·9	1·9	·02
Sphene	1·2		1·2			
Kaolinite		50·2		48·6	42	80·4
Talc		·3		1·2	·7	2
*†Bauxite		nil		4·9	nil	·2
Minor constituents		·5	·3	·2		
	100·2	100	100	100	100·4	100·32
*Diaspore				1·4		
Gibbsite				3·5		·2
†Total Alumina present in Bauxite		nil		4·6	nil	·1

These products of granites decomposed in situ may be termed either decomposed granites, kaolins, or pipe-clays. They are white or creamy-white, soft, earthy rocks which do not harden on exposure to the atmosphere, but gradually crumble down when wetted by rain. They are mixtures of varying proportions of sharply angular quartz-sand and of clay-substance (kaolinite with a little finely divided felspathic rock powder, or flour), with usually small proportions of colloid silica, either without or with aluminium hydrate in more or less negligible proportions, with a little ilmenite and with very small proportions of limonite.

Another type of the residual products of the alteration, probably largely by deep-seated hydro-metamorphism of pegmatites and aplitic granites, is the sericitic one. This type is at times erroneously regarded as produced by ordinary processes of weathering. The rocks are glistening white, exceedingly soft, silky-feeling masses, which do not harden on exposure to the air, but quickly disintegrate to a sandy powder when moistened by rain or when placed in water. Their chemical compositions, their physical properties, and the

microscopical examinations of them show that sericite is present in them to a considerable extent. The chemical compositions of two typical specimens are as follows:—

TABLE XIII.

	Minnehaha, Potaro District.	Mindrinetti, Surinam.
Quartz	23·23	20·30
Colloid Silica	·40	·38
Combined Silica	32	26·28
Aluminium Oxide	31·49	34·10
Iron Peroxide	·68	6·56
Magnesium Oxide	·21	·27
Calcium Oxide	·10	·02
Sodium Oxide	·25	·39
Potassium Oxide	1·25	1·97
Water	9·67	8·43
Titanium Oxide	·67	1
Phosphoric Anhydride	nil	nil
Manganese Oxide	nil	nil
	99·95	99·70

Their proximate mineralogical compositions appear to be—

TABLE XIV.

	Minnehaha, Potaro District.	Mindrinetti, Surinam.
Quartz	23·2	20·3
Colloid Silica	·4	·4
Sericite	14·3	21·6
Kaolinite	53·9	34·0
Talc	·7	·9
*†Bauxite	6·0	15·0
Ilmenite	1·3	2·0
Hæmatite		5·5
Minor constituents	·2	·3
	100	100
*Diaspore	3·1	12·8
Gibbsite	2·9	2·2
†Total Alumina present in Bauxite	4·6	12·3

These earths are mixtures of fine, sharply angular quartz-sand, kaolinite, and sericite, with lesser proportions of bauxite, the latter being present to the extent of 6 per cent. in the Minnehaha sample and to 15 per cent. in the one from Surinam. The principal differences between the Mindrinetti sample and the Omai sericitic laterites already described are in the higher proportion of limonite present in the latter and in the higher state of hydration of its bauxite. The more highly hydrated rock shows the setting power of true laterite; the rock of lower hydration does not in any way exhibit it.

Both these sericitic earths are more or less auriferous, and have been worked for gold.

Neither the pipe-clays, the products of the decomposition of granites, pegmatites, more or less aplitic granitite, and aplite in situ, nor the sericitic earths, their alteration products, have any claim to be

termed laterite, as they neither indurate on exposure to the atmosphere nor do they consist mainly or even to any extent of the hydrates of alumina.

Rocks other than highly aluminous ones showing to marked degrees the characteristic property of Buchanan's Laterite.—The gradual setting or hardening on exposure to the atmosphere of residual masses is not a characteristic only of either purely ferruginous, partly ferruginous and partly aluminous, or purely aluminous deposits. It may characterize to even a more marked degree other residuary deposits from igneous rocks. As an instance I may mention a mottled, creamy-white, and dark-red deposit which occurs in a low cliff at Kongkamo near the Ireng River in the territory recently assigned to Brazil. This is a clay-like mass which when first dug is quite soft and can be cut like cheese by an iron knife.[1] Upon exposure to the air the mass indurates gradually until the creamy-white parts attain a hardness of from 3·5 to nearly 4 of Mohs' scale, the dark-red parts becoming still harder. The composition of this material is shown by the following analysis:—

TABLE XV.

Quartz	·94
Colloid Silica	·58
Combined Silica	43·82
Aluminium Oxide	35·49
Iron Peroxide	4·40
Magnesium Oxide	·41
Calcium Oxide	·12
Sodium Oxide	·63
Potassium Oxide	7·53
Water	5·23
Titanium Oxide	·60
Phosphoric Anhydride	trace
Manganese Oxide	nil
	99·75

This corresponds to the following mineralogical composition:—

TABLE XVI.

Quartz	1
Colloid Silica	·6
Orthoclase	44·4
Plagioclase	5·9
Kaolinite	22·1
Talc	1·3
*†Bauxite	19·5
Ilmenite	1·2
Hæmatite	3·8
Minor constituents	·2
	100
*Diaspore	14·2
Gibbsite	5·3
†Total Alumina present in Bauxite	17·4

Microscopic examinations show that it is not like the ferruginous and aluminous masses of the lateritic earths, an infiltrated or

[1] It is thus used by the aboriginal Indians in making images and other carved ornaments.

a concretionary mass, but that it is made up of exceedingly fine felspathic rock powder, a few particles of which show the characteristics of plagioclase, with varying proportions of kaolinite, bauxite, and oxide of iron. Although it cannot be described as 'laterite' when judged on the lines laid down by Mr. Crook, its properties closely resemble the characteristic ones ascribed to that substance by Buchanan, and on account of which he proposed for it the name 'laterite'.

Oolitic 'Laterite'.—Du Bois, in his monograph on the laterites of Surinam, showed as figs. 2, 3, and 6 of pl. i two varieties of the components of Surinam laterite which he termed respectively "pisolithischen Eisenerzkonkretionem" and "oolithartigen Beauxit". I have obtained specimens closely resembling in general appearance these types—a red ferruginous one from near Arawak Matope on the Cuyuni River and a white one from the Berbice River. The specimen from the Cuyuni River consists of spheroids filled with dark-red ochre surrounded and cemented together by a white cementing material having a concretionary structure. It is an aggregate of ironstone pisolites cemented into a mass. That from the Berbice River consists of white and yellowish-white and of a few reddish spheroids cemented together by a white material in a similar manner to the Cuyuni specimen. When first obtained the specimens were quite soft, and could be very easily cut with a knife, the spheroids being the harder parts of them. The cementing material has gradually hardened, and now the rocks are somewhat harder than are any of the specimens of purely ferruginous or aluminous concretionary laterite I have described in this paper. The cementing material is now the hardest part of the specimens, the innermost part of the spheroids the softest. From their very marked properties of induration on exposure to the atmosphere these rocks appear to have a well-founded claim to the term 'laterite' as used by Buchanan. But they are not laterite in the sense of being mainly aluminous in composition, the restriction which has recently been superimposed on Buchanan's original description of laterite. This is clearly shown by the chemical and proximate mineralogical compositions detailed in the following analyses:—

Table XVII.

	Matope, Cuyuni (red).	Berbice (white).
Quartz	·06	6·79
Colloid Silica	·40	·33
Combined Silica	24·07	36·92
Aluminium Oxide	21·42	34·82
Iron Peroxide	40·80	3·85
Magnesium Oxide	·85	·16
Calcium Oxide	·17	·07
Sodium Oxide	nil	nil
Potassium Oxide	·20	·32
Water	11·41	12·74
Titanium Oxide	·95	3·85
Phosphoric Anhydride	trace	trace
Manganese Oxide	nil	nil
	100·33	99·85

TABLE XVII (*continued*).

	Matope, Cuyuni (red).	Berbice (white).
Quartz	·1	6·8
Colloid Silica	·4	·3
Orthoclase	1·2	1·9
Plagioclase	·8	·3
Kaolinite	45·5	76·3
Talc	2·7	·4
*†Bauxite	4·4	6·5
Ilmenite	1·9	7·4
Hæmatite	19	
Limonite	24·2	traces
Minor constituents		·1
	100·2	100
*Gibbsite	4·4	6·5
†Total Alumina present in Bauxite	2·9	4·2

The cementing material of these rocks is kaolinite with varying proportions of felspathic rock powder and perhaps some bauxite. The contents of the spheroids in the red one from the Cuyuni is presumably a mixture of oxide and hydrate of iron, of which constituents the rock contains over 40 per cent. In the white one from the Berbice River both spheroids and cementing material appear to consist mainly of kaolinite with some bauxite. In their compositions the rocks offer little resemblance to those of the two varieties of purely ferruginous and purely aluminous laterite described by Du Bois which they so very closely resemble in other respects.

(*To be concluded in the December Number.*)

IV.—The Cretaceous Cirripede *Pollicipes lævis*, J. de C. Sowerby.

By Thomas H. Withers.

J. DE C. SOWERBY (1836, p. 335) founded two new species of *Pollicipes* from the Gault of Folkestone. To the one, based on a carina and tergum, he gave the name *P. lævis* (p. 335, pl. xi, fig. 5); to the other, based on a rostrum and one of the latera of the lower whorl, the name *P. unguis* (p. 335, pl. xi, fig. 5*). He also referred a carina and tergum from the Upper Greensand of Blackdown to *P. lævis* (p. 340, pl. xvi, fig. 1), but published no description of them.

J. Steenstrup (1837, p. 363) founded the species *P. elongatus* on a scutum and tergum from the Danian of Denmark, but later (1839, p. 409, pl. v, figs. 7–11, 7*) referred the type-specimens, with other valves, to Sowerby's *P. lævis*.

Subsequently, C. Darwin (1851, p. 55) maintained the species *P. elongatus*, at least for the scutum, and (p. 65) recognizing that the valves from the Gault of Folkestone described by Sowerby under the names *P. lævis* and *P. unguis* represented a single species, thought it advisable to adopt for it Sowerby's name of *P. unguis*, especially as Steenstrup (1839) had described valves belonging to different species under Sowerby's name *P. lævis*.

The valves from the Upper Greensand of Blackdown remain to be considered.

Since it cannot be ascertained that the specimens figured by Sowerby are still preserved, it is proposed to describe and figure some similar valves from the same horizon and locality, formerly in the collection of the late W. Vicary, F.G.S. They were recorded by the Rev. W. Downes, F.G.S., in List of Fossils from Blackdown (Q.J.G.S., 1882, vol. xxxviii, p. 86), and are now preserved in the British Museum (Natural History).

C. Darwin (1851, p. 80) says of the valves figured by Sowerby " . . . the *P. lævis* from Blackdown . . . seems to be certainly a distinct species, and possibly a *Scalpellum*: no details are given". Darwin apparently did not see the actual specimens, or he would at once have recognized that they did not belong to *Scalpellum* but to *Pollicipes*. The parietes of the carina are not separated by any defined ridge or angle from the tectum as in *Scalpellum*, neither is the tergo-lateral margin of the scutum divided into two distinct lines, as is the case in *Scalpellum*, owing to the abrupt ending of the upturned lines of growth.

Since there is a general similarity in the characters of these valves, and since no other Cirripede remains have as yet been found associated with them in the Blackdown Beds, it seems safe to regard them as belonging to a single species, namely—

POLLICIPES IMBRICATUS, sp. nov. Figs. 1–3.

1836. *Pollicipes lævis*, J. de C. Sowerby, Trans. Geol. Soc., ser. II, vol. iv, p. 340, pl. xvi, fig. 1 (*non* pl. xi, fig. 5).

Diagnosis. — Valves thin, composed of a number of consecutive and slightly imbricate segments, the lines of junction being marked on their external and inner surfaces by shallow obtusely V-shaped grooves. Scutum trapezoidal in outline; apex blunt; occludent portion twice as wide as the tergo-lateral portion; basal margin nearly at right angles to the occludent margin, and to the lower part of the tergo-lateral margin; there is no deep pit on the inner surface for the adductor scutorum muscle. Carina triangular in transverse section, with basal margin angular (about 92°).

Material.—A nearly perfect carina on a hard shelly matrix (B.M., I. 5392). A portion of a carina (B.M., I. 13518), portions of two scuta (B.M., I. 13519, I. 13520), and portions of two terga (B.M., I. 13521, I. 13522); all these are free from matrix. The whole of the material is silicified.

Holotype.—The right scutum (Figs. 1*a*, *b*).

Horizon and Locality. — Albian, Upper Greensand: Blackdown, Devonshire.

Description of Specimens.—Right scutum (Figs. 1*a*, *b*; B.M., I. 13519) convex, valve thin, divided unequally by a ridge extending from the apex to the basi-lateral angle: occludent margin slightly convex; basal margin nearly straight; basi-lateral angle blunt; tergo-lateral margin convex, and protuberant near the middle. The unequally-spaced surface-grooves, which represent the growth periods, are very slightly sinuous on the occludent portion; on the tergo-lateral portion they are sharply upturned, and on nearing the margin curve inwards towards the apex. Occludent margin (from apex to rostral angle) 7·5 mm., tergo-lateral margin (from apex to basi-lateral angle) 8 mm., basal margin 5 mm.

Left tergum (Fig. 2; B.M., I. 13521) sub-rhomboidal, slightly convex; a rounded ridge, steep on the carinal side, divides the valve into two unequal portions; the carinal portion is somewhat depressed and in its widest portion is about two-thirds the width of the occludent portion; the occludent portion is again divided almost equally by an obscure ridge from the apex to the scutal margin, which is immediately followed by a wide groove, almost parallel to the occludent margin. The well-marked grooves, of which there are seven on the portion preserved, are straight on the carinal portion, and on the occludent portion are straight until they reach the inner edge of the wide groove, and thence are recurved until they reach the occludent margin, where they are more sharply curved towards the apex.

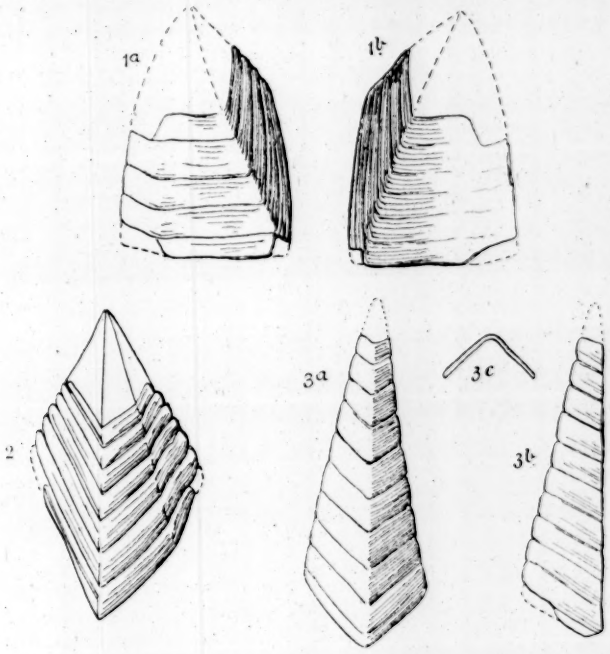


Fig.
1*a*. *Pollicipes imbricatus*, Withers, sp. nov. External view of right scutum. Albian, Upper Greensand: Blackdown, Devonshire. B.M., I. 13519.
1*b*. Id. Inner surface of same.
2. Id. External view of left tergum. B.M., I. 13521.
3*a*. Id. External view of carina. B.M., I. 5392.
3*b*. Id. Side view of same.
3*c*. Id. Transverse section of same at one-third from base. All figures × 4 diam.

Length 9 mm., greatest breadth 6 mm., length of occludent margin 5·5 mm., length of scutal margin 6·5 mm.

Carina (Figs. 3*a–c*; B.M., I. 5392) almost straight, with thin walls, widening gradually from the apex, subcarinated, triangular in transverse section, about twice as wide as high; apex probably pointed; basal margin angular (about 92°). The only ornamentation

is the well-marked grooves, of which there are eleven on the portion preserved.

Length 10·5 mm., greatest breadth 3·5 mm.

Measurements.—As all the valves are slightly broken, it is impossible to give accurate measurements, but those given probably err very little. The broken parts are indicated in the figures.

Comparison with other Species.—The scutum of *Pollicipes imbricatus* agrees with that of *P. elongatus*, J. Steenstrup (1837), from the Upper Chalk (Danian) of Denmark, in its general outline, and in having the wide, regularly spaced, well-marked grooves about the same distance apart as the growth-lines of *P. elongatus*. It is distinguished from *P. elongatus*, among other characters, in the occludent portion of the valve being twice the width of the tergo-lateral portion. In *P. elongatus* the occludent and the tergo-lateral portions are the same width. The tergum of *P. imbricatus* is altogether different from that valve referred to *P. elongatus*, and therefore need not be discussed. The carina and tergum of *P. imbricatus* were considered by J. de C. Sowerby (1836, p. 340) to belong to his *P. lævis* = *P. unguis*. The carina disagrees with that of *P. unguis* in being much narrower, straighter, more angular in transverse section, and in the presence of the well-marked grooves, which make a much more acute angle than do the growth-lines in *P. unguis*. The tergum of *P. imbricatus* differs from that of *P. unguis* mainly in having a much wider groove running parallel to the occludent margin, and about half the width of the occludent portion of the valve. The scutum of *P. unguis* differs in the general outline of the valve, which approaches an equilateral triangle, and consequently the apex is much more acute than in *P. imbricatus*. The scutum of *P. unguis* is also much thicker, and has a deep pit for the adductor scutorum.

There is little doubt that *P. imbricatus* is closely allied to *P. unguis*, J. de C. Sowerby, and *P. glaber*, F. A. Roemer (1841, p. 104, pl. xvi, fig. 11).

The scutum of *P. imbricatus* is distinguished from all other scuta that I have seen, either of *Pollicipes* or *Scalpellum*, by the entire absence of any pit or depression for the adductor scutorum.

Pollicipes unguis, J. de C. Sowerby. Figs. 4, 5.

1836. *Pollicipes unguis*, J. de C. Sowerby, Trans. Geol. Soc., ser. II, vol. iv, p. 335, pl. xi, fig. 5*.
1836. *P. lævis*, J. de C. Sowerby, pag. cit., pl. xi, fig. 5.
1845(?). *P. unguis*, A. Reuss, Böhmischen Kreideformation, p. 17, pl. v, fig. 44.
1850. *P. unguis*, H. B. Geinitz, Das Quadersandsteingebirge, p. 100.
1850. *P. lævis*, H. B. Geinitz, ibid.
1851. *P. unguis*, C. Darwin, Pal. Soc. Monogr. Foss. Lepadidæ, p. 64, pl. iv, fig. 1.
1853. *P. unguis*, C. Darwin, Ray Soc. Monogr. Sub-class Cirripedia, Synopsis et Index Systematicus, p. 637.
1865. *P. unguis*, Salter & Woodward, Cat. and Chart. Foss. Crustacea, p. 27, pl. i, fig. 6.
1877. *P. unguis*, H. Woodward, B.M. Cat. Brit. Foss. Crustacea, p. 141.
1886. *P. unguis*, J. Kafka, Sitz. Ber. k. Böhm. Gesell. Wiss., Prag, 1885, p. 573.
1887. *P. unguis*, Fritsch & Kafka, Crust. Böhmischen Kreidef., p. 12.

This common Gault species was founded by J. de C. Sowerby on a rostrum and one of the latera of the lower whorl. Darwin (1851,

p. 64, pl. iv, fig. 1) figured a number of valves belonging to a single individual, namely, a carina, a pair of terga, a rostrum, a sub-rostrum, a pair of upper latera, a pair of latera of the lower whorl from the carinal end of the capitulum, and two other latera of this same whorl from one side of the rostral end of the capitulum. These are preserved in the Museum of Practical Geology, Jermyn Street. Darwin says of the scutum: "Although the scutum is, unfortunately, at present unknown, there can be scarcely any doubt that it would closely resemble that of *P. glaber*, and therefore I have not hesitated, in this instance, to break through my rule of exclusively taking the scutum as typical in *Pollicipes*: should, hereafter, a scutum be found in the Gault like that of *P. glaber*, it may, with considerable confidence, be named as belonging to this species."

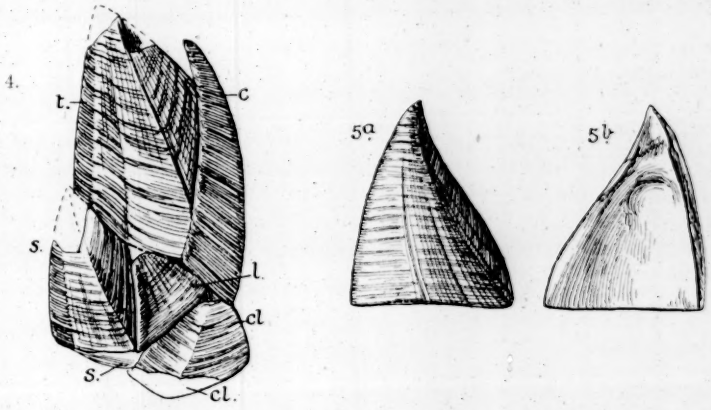


Fig.
4. *Pollicipes unguis*, J. de C. Sowerby. External view of the right side of part of a capitulum of a young individual. × 6 diam. Albian, Gault: Folkestone, Kent. B.M., I. 13523. *c.* carina; *s.* scutum; *t.* tergum; *l.* upper latus; *c.l.* carinal latus.
5*a*. Id. External view of right scutum of a much older individual. × 2 diam.
5*b*. Id. Inner surface of same, showing the deep pit for the adductor scutorum muscle.

In the British Museum (Natural History), registered I. 13523, there is a young example of *P. unguis*, with several of the valves of the capitulum in position (Fig. 4). The right side of the capitulum is uppermost, and shows the carina, scutum, tergum, upper latus, and carinal latus. Its importance lies in the fact that the valves are almost in their original positions, and that it includes the scutum, which has not been described previously. The portion of the capitulum preserved is twice as long as wide. Its greatest length is 9 mm. and its greatest breadth 4·5 mm. With the exception of the scutum the various valves of *P. unguis* have been fully described by Darwin, and in these circumstances it is proposed here to describe the scutum alone.

The description of the external characters of the scutum is based

mainly on that valve seen in the young individual (Fig. 4) and on a much larger scutum of another individual (Figs. 5*a*, *b*). The description and figure of the inner surface of the scutum is taken from the larger valve, now in my possession.

Description of Scutum.—General outline approaching an equilateral triangle, convex, moderately thick, divided into two unequal portions by a ridge extending from the apex to the basi-lateral angle, the occludent portion being about twice as wide as the tergo-lateral portion. A further ridge extends from the apex to about the middle of the basal margin, slightly nearer the rostral angle; basal margin almost straight, making with the occludent margin an angle of about 71°, and with the tergo-lateral margin an angle of about 63°; occludent margin slightly convex; tergo-lateral margin protuberant near the base, and incurved towards the apex; rostral angle sharp; basi-lateral angle blunt. Surface of valve almost smooth, with fine longitudinal striæ, which are more strongly marked in some specimens. The deep pit for the adductor scutorum takes up the whole of the lower two-thirds of the valve. From the top of this pit a depression runs to the apex. This depression, which is marked with fine oblique lines, extends on one side to the tergo-lateral margin, and on the other is bounded by the inner occludent margin, which is the same width the whole length of the valve. Length of occludent margin (from apex to rostral angle) 14 mm., length of basal margin 11·5 mm., length of tergo-lateral margin (from apex to basi-lateral angle) 15·5 mm.

Horizon and Locality.—Albian, Gault: Folkestone, Kent.

Comparison with other Species.— Darwin (1851, p. 67) says of *P. unguis*: "As before remarked, this species is very closely related to the cretaceous *P. glaber*, of which it is evidently the representative in the Gault; the chief difference consisting in the more elongated form and greater size of its upper latera, which, in *P. unguis*, exceed half the length of the tergum, whereas in *P. glaber* they are only one-third of its length. The carina, in the present species, has its basal margin, perhaps, less pointed, and has a narrow linear channel along its edges; but I am not at all sure that this latter character does not vary. Lastly, the anterior lower latera in *P. unguis* are thinner, and rather more convex, with the basal margin more arched and protuberant, with the external oblique ridge very much more central." The scutum of *P. unguis*, as expected by Darwin, is extremely like that of some forms of *P. glaber*, and apparently differs only in being much thicker. Some of the differences between the various valves of *P. unguis* and *P. glaber* given by Darwin are not apparent in some specimens. There is much variation in the valves of both species, and it is highly probable that some of the differences will eventually be correlated with the differences of horizon. Consequently, until a larger number of specimens of both species from definite horizons have been examined, it is not advisable to attempt to point out probable differences. *P. unguis* is confined to the Gault, and *P. glaber* ranges right up into the Upper Senonian.

My thanks are due to Dr. F. A. Bather, Mr. G. C. Crick, and Mr. C. P. Chatwin for help in connexion with this paper.

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V.—The Plasticity of Rocks and Mountain Building.

By R. M. Deeley, M.Inst.C.E., F.G.S.

BRITISH geologists must have read Professor Coleman's Address to the Geological Section of the British Association with great pleasure and interest. As Professor Coleman remarks, geology finds some of its most seductive problems in the neglected extremes of the earth's history. Out of the apparent tangle of the 'drifts' and Archæan Gneisses Canadian geologists are now evolving an orderly sequence which must exercise considerable influence upon the progress of geology in other lands. The seemingly unnatural conjunction of Pleistocene and Archæan, Professor Coleman states, has furnished the clue to certain puzzling problems of the Archæan.

During a trip from Regina to Winnipeg this summer I had the pleasure of riding at the end of a Canadian Northern train with a young railway engineer, and discussing with him the problems that

have to be faced to keep the line in good condition during the winter. In many places the line passes over areas of waterlogged ground. During the winter the cold penetrates the earth and freezes this water to depths of 10 feet or more. The ice thus formed expands, raises the earth into domes and makes the road bed very irregular. It is the business of the engineer to see that these irregularities are made good by packing up the line, a troublesome task with the temperature many degrees below zero F.

The 'Canadian shield' consists of a base of granite or gneiss rising into numerous domes which are somewhat irregularly scattered over the area. Upon them rest the Keewatin and newer rocks. After the deposition of the Keewatin Series the land rose and formed a great mountain system, which was afterwards almost completely destroyed by denudation.

The rising of this mountain system seems to have been due to the heating up of portions of what are now known as the Laurentian granites, rather than to crushing or folding. We must regard the mountain ranges as floating upon the earth's crust, their lightness being due either to their high temperature bases or small relative density. Crushing and folding, apart from the heating that may result from it, do not seem competent to alone form high mountain systems; for the folds would not cause a great rise of the surface—the mass would sink as do the sediments deposited upon a sea-bottom. It seems most reasonable to regard mountain ranges as being due to the high temperature of the deep-seated rocks causing an uplift by expansion, just as the railway track is lifted by the freezing of the water beneath. If this view be the correct one, then it follows that the disappearance of the mountain range must have been due to the cooling down of the Laurentian rocks beneath; for otherwise the mountain peaks would have risen as fast as they were denuded.

Professor Coleman gives a very interesting explanation of the reason for the formation of the dome-shaped masses of granite and gneiss upon which the Keewatin rocks rest. He suggests that the lower rocks became plastic, that the Keewatin above was unequally heavy, and that the granite rose in domes where the lightest loads were situated.

It must be admitted that the formation of great depressed areas, such as that of Lake Superior, is a difficulty. Here it is considered that the granite below became so fluid that it was ejected at the edges and allowed the area from beneath which it came to sink bodily. But if such be the case, how is it that this portion of the earth's crust did not rise again? It may be that to some extent the explanation is that the deeper portions of the earth's crust are plastic, not viscous. Plastic materials do not flow unless the stress exceeds some particular limit. A mountain range may therefore be stable although its height may be hundreds of feet greater or less than is warranted by the density of the crust at the spot.

Professor Coleman recognizes that the weight of the ice which once rested on the 'Canadian shield' depressed it, and that since the ice melted away there has been a rise of the area. He says these sinkings and risings must be accomplished by plastic flow outwards from

beneath the loaded area, and inwards towards the area relieved of its load. He rightly uses the word plastic here. And here is another contrast between the properties of the ice-sheets which played an important part in the formation of some Canadian deposits and the rocks themselves. The ice moved much as a truly viscous liquid would have done whilst the deep-seated rocks underwent plastic deformation. The ice formed and maintained an almost level upper surface like that of the Antarctic Plateau, whilst the plastic rocks allowed themselves to be cut into hill and dale until the stresses produced were sufficiently great to allow of plastic flow. Plastic solids never reach a condition in which the stresses are equal in all directions; they cease to flow when the stress falls below some particular value. Although it is true that the solid, liquid, and gaseous states are continuous, the liquid differs from the plastic solid inasmuch as it yields to any stress however small, whereas the solid does not begin to deform continuously until the unbalanced stress reaches some particular value depending upon the nature of the material and the temperature. With rise of temperature this limiting stress becomes smaller and smaller, and when it falls to zero the solid becomes a liquid. For all practical purposes, however, substances which flow (shear) under very small stresses may be regarded as viscous (liquids). Professor Coleman shows that although the 'Canadian shield' was depressed by the weight of the Pleistocene ice resting upon it, it has not risen as much as might have been expected considering the weight of ice melted away; probably this is also owing to the *plastic* nature of the earth's crust.

There is another interesting property of plastic substances which might be referred to. When a test bar of iron or steel is drawn out to some extent in a testing machine and its length then measured, it will be found that, after giving it a light blow, it will have shortened again somewhat. If the bar has suffered compression it will have lengthened again. In many cases it has been found that an earthquake has resulted in a rise or fall of the land locally. May it be that the jar of the strained plastic crust has released strains in a similar manner and given rise to sudden change of form?

VI.—Note on the Type-specimens of *Ammonites cordatus* and *Ammonites excavatus*, J. Sowerby.

By G. C. Crick, F.G.S., British Museum (Natural History).[1]

J. SOWERBY'S type-specimens of *Ammonites cordatus* and *Ammonites excavatus* have been dealt with comparatively recently by Miss M. Healey in the *Palæontologia universalis* (sér. II, fasc. 1, August, 1905, Nos. 94, 94*a*, and 92, 92*a*, 92*b* respectively), but her statements require a little modification in some details. Both specimens are in the British Museum collection, and were described and figured in the *Mineral Conchology*.

1. *Ammonites cordatus*.—Miss Healey gives the date of publication of this species as 1812, and observes that "The date 1813 is given on the plate, but on the title page the date is 1812". From this remark

[1] Published by permission of the Trustees of the British Museum.

it is obvious that the date of publication of the species was taken from the title-page of vol. i, this bearing the date 1812. But, as is well known, the *Mineral Conchology* was issued in 113 numbers or parts, the first sixty-five parts being by James Sowerby, and the rest by his son, James de Carle Sowerby. Vol. i included Nos. i–xviii, which appeared between 1812[1] and August, 1815. The figures and description of *Ammonites cordatus* (pp. 51–2, pl. xvii, figs. 2 and 4) were published in No. iv, which is dated April 1, 1813, the same date appearing on the plate. It is obvious, therefore, that the date of publication of the species is not 1812, but 1813.

Sowerby figured two specimens (figs. 2 and 4), but regarded the original of his fig. 2 as the type of his species; for, referring to the fossil represented in his fig. 4, he says: "I am much inclined to consider it as a distinct species." The original of fig. 2 is therefore the holotype, and that of fig. 4 a paratype. Respecting the paratype Miss Healey states: "The difference between the photograph of the paratype and the original figure [fig. 4] is striking, but there can be no doubt about its identity, as it bears a label on which is written in Sowerby's handwriting (*Ammonites cordatus*, M.C. 17, fig. 2, 4) and the green wafer with which he marked figured specimens." As will be seen from a comparison of Sowerby's figure of the holotype with the photograph of the same given in the *Palæontologia universalis*, Sowerby's figure is reversed; but it would seem from the figures of the paratype given on the same plate of the *Palæontologia universalis* that in this case Sowerby's figure was not reversed. However, a careful examination of the paratype, especially of the septal surface at the anterior end of the specimen, shows that Sowerby's figure, so far as the outer whorl is concerned, is reversed; and that the inner whorls have been drawn from the opposite side of the specimen. So far, then, as the outer whorl is concerned, the photograph reproduced in the *Palæontologia universalis* represents the opposite side of the specimen to that figured in the *Mineral Conchology*, and, in a great measure, accounts for the striking differences between the figure in the *Palæontologia universalis* and Sowerby's figure. Even if the specimen had not been labelled in Sowerby's handwriting, there could be no doubt whatever about its identity, since the details of the septal surface at its anterior end have been carefully copied in Sowerby's figure.

2. *Ammonites excavatus*.—Miss Healey gives the date of publication of this species as 1818. It is true that this is the date on the title-page of the volume (vol. ii) in which that species was described and figured (p. 5, pl. cv), but, as has been mentioned above, the *Mineral Conchology* was published in numbers or parts; and vol. ii included Nos. xix–xxxv, which were issued between October 1, 1815, and June 1, 1818, both dates inclusive. The figure and description of *Ammonites excavatus* appeared in No. xix, which is dated October 1, 1815. The date of publication of the species should therefore be 1815, and not 1818.

[1] The dedication of the work, and each plate in No. i, which included pls. i–iii with explanatory text, is dated May 25, 1812.

There are considerable differences between Sowerby's figure and the photograph of the type-specimen reproduced in the *Palæontologia universalis* (sér. II, fasc. 1, No. 92*a*), but it should be mentioned that Sowerby's figure, besides being reversed (as usual) and somewhat restored, represents the fossil *without* the natural internal cast of the body-chamber (which, as Sowerby himself observed, is separated from the rest of the shell), whilst in the photograph this portion of the fossil has been placed in its natural position.

VII.—Notes on the Morphology and Generic Nomenclature of some Carboniferous Arachnida.

By R. I. Pocock, F.L.S., F.Z.S.

1. On *Anthracomartus* and *Promygale*.

In his monograph of Palæozoic Arachnida published in 1904, Dr. Fritsch divides the order Araneæ into two suborders—the Arthrarachnæ, Haase, containing the Arthrolycosidæ, and the Pleuraraneæ, Fritsch, containing the Hemiphrynidæ (*Hemiphrynus*) and the Promygalidæ (*Promygale*).

Haase, Beecher, and others, whom Fritsch follows, were no doubt right in referring *Arthrolycosa* and allied genera to the order Araneæ, but the Pleuraraneæ are in my opinion nothing but Anthracomarti, the genus *Promygale* itself being synonymous with *Anthracomartus*. The form of the carapace and structure of the appendages are the same in the two. The constriction between the prosoma and opisthosoma occurs in both. The segmentation of the opisthosoma is similar in the two, even in the presence of a longitudinal sulcus dividing the pleural laminæ into an external and an internal moiety, and in the angulation of the posterior border of the posterior sternal plates.

Certain discrepancies in the figures published by Fritsch inevitably rouse a feeling of scepticism on the score of the accuracy of the restorations they represent. In *Promygale bohemica* (fig. 20) there are eight dorsal plates; each of the anterior seven is furnished with a divided pleural lamina, the posterior border of the eighth being produced in the middle line to form an unpaired plate. But in fig. 21, showing the ventral side, the last-mentioned plate is paired by a longitudinal sulcus. In *P. elegans* (fig. 26*a*, dorsal view), on the other hand, there are only seven dorsal plates. On the seventh the inner moieties of the pleural laminæ are not shown, but on each side of the opisthosoma ten sclerites represent the outer moieties of these laminæ. It is impossible to refer these with any certainty to their appropriate somites, and impossible to say which of the original seven pleural laminæ have been subdivided to add to the number. A similar augmentation is shown in fig. 23, representing *P. rotundata*. This feature, if existent, should constitute a generic difference between *P. bohemica* on the one hand and *P. elegans* and *P. rotundata* on the other; but the drawings of the actual specimens of *P. elegans* (pl. xv, fig. 2) and of *P. rotundata* (text-fig. 24, p. 20) afford, so far as I can see, no support to the view that the pleural laminæ are numerically in excess of the somites. On the contrary, there appears to be complete agreement between them in this particular.

Again, in the dorsal view of *P. bohemica* (text-fig. 20, p. 19), the outer moieties of the posterior four pairs of pleural laminæ are marked with an additional concentric sulcus, which is continued across the unpaired lamina of the last tergal plate. This is no doubt the sulcus defining on the ventral side the outer plate of the laminæ, which is present in all the well-preserved specimens of *Anthracomartus* that I have seen.

One other difference, already referred to, between *Promygale bohemica* and the species of *Anthracomartus* is the presence in the former, to judge from the drawings, of an additional tergal plate, cut off by a sulcus from the posterior half of the seventh tergum, making eight of these plates visible on the dorsal side. Apart from the fact that this plate is not so divided, either in *Eophrynus*, *Anthracosiro*, or *Anthracomartus*, a fact sufficient in itself to cast doubts upon the reality of its segmentation in *Promygale bohemica*, it is noticeable that Fritsch himself omits the sulcus in question from his drawing of *P. elegans* (fig. 26, p. 21), and thus does not ascribe even a generic value to its presence in *P. bohemica*. Without further evidence I find it hard to believe in its existence.

With regard to the restoration of the ventral side of the same species (text-fig. 21), since the posterior margins of the sterna are represented by dotted lines, it may be assumed that these plates were cracked and obliterated beyond the possibility of accurate decipherment. All the more remarkable, therefore, must be regarded the circumstance that the so-called comb-like organs are so well preserved as to admit of detailed restoration. I suggest that these alleged organs are really the two deep impressions which lie, one on each side, of the anterior sternal plates in *Anthracomartus*. The settlement of this question, however, must be left until an opportunity of examining the fossil has been afforded to some competent Arachnologist.

Respecting the shape of the sternal plates as indicated on this drawing, it is noticeable that Fritsch has represented them by dotted lines running parallel with each other and at right angles to the longitudinal axis of the body, whereas the drawing of the original specimen of *P. elegans* (pl. xv, fig. 4) shows quite clearly that the sterna, at least in the posterior part of the body, are angularly curved in the middle line, exactly as in the examples of *Anthracomartus* that I have seen, thus establishing another point of similarity between this genus and *Promygale*.

In referring the genus *Promygale* to the Araneæ and *Anthracomartus* to the Opiliones, in spite of the striking similarity between them, Fritsch relies upon his alleged discovery of jointed appendages, representing the spinning mamillæ of the Araneæ, upon the lower side of the opisthosoma in *Promygale* and their absence in *Anthracomartus*. In the restoration of *P. elegans* (text-fig. 26, B, p. 31) these appendages are shown as two pairs of slender three- or four-jointed limbs attached to the second and third sternal plates, each limb of a pair being widely separated from its fellow of the opposite side. I cannot think the drawings of the original specimens justify this conclusion. In fig. 3, pl. xv, showing the ventral side of *P. elegans*, the author has portrayed pieces of what he regards as small limbs scattered

without order, amongst other foreign bodies, over the exposed surface of the ventral side of the opisthosoma. Each piece consists of three or four segments, but they differ from each other so greatly in length and thickness that no successful attempt can be made to pair or homologize them. Moreover, no clue is afforded as to their original situation, and it is permissible to suggest that perhaps after all they are not appendicular in nature but fragments of the sternal skeleton; or indeed they may not belong to the organism at all like the so-called parasitic Spiroglyphs with which the fossil is strewn. And if appeal be made to fig. 4 on the same plate, representing the ventral side of another specimen, referred to the same species, and showing what might be interpreted as a pair of stout two-jointed limbs diverging from each other and from the middle line a little in front of the centre of the lower surface of the opisthosoma, it may be replied that, apart altogether from being in contact in the middle line, these segments bear no sort of resemblance to the restored opisthosomatic limbs depicted by Fritsch. I venture to suggest that, if appendicular in nature, the segments in question belong to one of the prosomatic appendages misplaced. But the angle they form coincides suspiciously with the angular curvature of the sterna of the mid region of the opisthosoma in *Anthracomartus*. In the specimens of the latter genus that I have seen, as well as in Ammon's drawing of *A. palatinus*, the borders of the sterna show up as angular ridges, the anterior and usually the strongest lying near the middle of the opisthosoma.

With respect to the eyes, two pairs are represented in the restoration of *Promygale bohemica*; but the drawing of the original specimen shows only a single pair placed differently from either of the pairs outlined in the restoration.

Since, then, critical examination of Fritsch's drawings of *Promygale* fails to produce any trustworthy evidence that this genus can be separated from *Anthracomartus*, there is no choice but to regard the two as identical.

As regards the Hemiphrynidæ, I have no doubt that these Arachnida must also be assigned to the Anthracomarti, since, so far as can be judged, they have the characters of that order. Most emphatically they do not belong to the order Araneæ. The genus *Hemiphrynus* was based upon two species—*H. longipes* and *H. hofmanni*; but since these cannot be congeneric, if the restorations approach reality, I propose to select *H. hofmanni* as the type.

The following features in Fritsch's restoration of *Anthracomartus* call for comment (text-fig. 41, A dorsal, B ventral side). In the figure representing the dorsal side, the palpi (appendages of the second pair) show six segments with a terminal knob, projecting beneath the fore border of the carapace. The subequality in the length of the segments is quite unusual in the Arachnida, and if the terminal knob be a segment there is one segment in excess of the normal found in the class. The following four pairs of appendages consist of eight segments, including the coxæ. This number also exceeds by one the normal found in Arachnida, the additional segment arising from the division of the femur. But in the first two pairs of these appendages the proximal segment

of the femur is twice the length of the distal, whereas in the last two it is only one-third of the length. Since the femora are sometimes segmented in the Chelonethi (Pseudoscorpiones), it would be rash to reject unhesitatingly on *a priori* grounds Fritsch's restoration of the legs in *Anthracomartus*; but since the legs of the specimens of the genus that I have seen, as well as of the allied genera *Eophrynus* and *Anthracosiro*, have normal and unsegmented femora like a great majority of the Arachnida, there can be very little doubt, I imagine, that Fritsch has mistaken fortuitous cracks for intersegmental joints. And this is by no means a solitary case where a knowledge of the constancy of certain morphological features in the Arachnida enforces the imposition of such an interpretation upon his restorations.

2. On the Structure and Classification of the Phalangiotarbi.

The name Phalangiotarbi was proposed by Haase in 1890 for a group accorded subordinal rank under the Opiliones. It contained the genus *Phalangiotarbus* created for the species described by Dr. Henry Woodward as *Architarbus subovalis*. I agree with Haase in thinking the type-species of *Architarbus* and *Phalangiotarbus* generically distinct, and with Fritsch in regarding them as belonging to the same order of Arachnida. But whereas Fritsch referred them to a family of Opiliones, the Architarbidæ, it appears to me necessary to give them higher systematic rank. I therefore retain the term Phalangiotarbi, leaving open for the moment the question of their right to inclusion in the Opiliones. In addition to the genera just mentioned I assign to this group *Geratarbus*, *Geraphrynus*, and the new genus *Opiliotarbus* described below.

The morphology of this series of genera has hitherto baffled research; and I am indebted to well-preserved material kindly lent to me by Dr. Wheelton Hind, Mr. S. Priest, the late Mr. W. Madeley, Mr. H. Johnson, F.G.S., and Mr. Walter Egginton for the new interpretation of the facts set forth in the following pages.

Since more than one species has in some cases been referred to the genera, I take this opportunity of stating that the type-species of each is as follows: *Architarbus*, Scudder, 1868; type, *A. rotundatus*, Scudder. *Geraphrynus*, Scudder, 1884; type, *G. carbonarius*, Scudder. *Geratarbus*, Scudder, 1890; type, now selected, *G. lacoei*, Scudder. *Phalangiotarbus*, Haase, 1890; type, *Architarbus subovalis*, H. Woodw. *Opiliotarbus*, nov.; type, *Architarbus elongatus*, Scudder.

In the diagnosis of *Geraphrynus* published by Scudder in 1890, the genus is said to possess a "posterior shield of the cephalothorax, the anterior triangular fragment of which slopes upwards to the ridge [of the cephalothorax], while the hinder portions with their transverse scorings and ridgings lie on a plane below . . . this post-thoracic plate crowds down the middle of the six following segments".

Comparing the dorsal and ventral views of my specimens of *Geraphrynus* with Scudder's figure of *G. carbonarius*, I am forced to conclude that the so-called post-thoracic plate has no existence as such, but is composed of the anterior two or three sternal plates of the opisthosoma and the posterior projection of the carapace. It is

the latter area which "crowds down the middle of the six following segments"; the sternal plates are the anterior "triangular fragment" sloping upwards to the ridge as well as the "hinder portions with transverse scorings and ridgings" that "lie on a plane below"; and the median ridge is the sternal area of the prosoma. In a crushed specimen confusion might easily arise between these dorsal and ventral elements of the skeleton.

This interpretation, if correct, disposes of Haase's view of the morphology of *Architarbus*. This author modified Scudder's drawing to suit his idea that *Architarbus* belongs to the Amblypygous Pedipalpi. The anterior part of Scudder's post-thoracic plate he regarded as the posterior sternal plate of the prosoma and its posterior part as the genital plate of the opisthosoma. Scudder's drawing, however, does not justify Haase's rendering of it, full of ingenuity though his interpretation was.

Commenting on Haase's opinion, Hansen states that of the three specimens figured by Scudder as *G. carbonarius* "only one, the one figured on pl. xl, fig. 12, can with any certainty be classed amongst the Amblypygi"; and in an explanatory foot-note he adds that the figure shows eleven distinct sternites of exactly the same shape as those of *Phrynus*. This statement, however, is not true. No *Phrynus* has four narrow sterna following and curving round the genital plate nor the posterior sterna so well defined and large as shown in Scudder's figure. Hansen, moreover, ignores the existence of the plates in front of the backwardly bulging plate which, by implication, he takes for the genital operculum; and he is compelled to assume that the first pair of appendages exhibited by the fossil has been quite wrongly drawn. He seems, in fact, to trust to the accuracy of the drawing where it compares favourably, as he thinks, with a *Phrynus*, and assumes inaccuracy where the discrepancies are irreconcilable. The figure admittedly resembles a *Phrynus* superficially. So much so, indeed, that I feel sure the artist, Mr. H. Emerton, made use of a *Phrynus* to help his delineation; and this supposition is borne out by certain discrepancies between Scudder's description of the fossil and Emerton's figure of it.

The difficulties, then, that have hindered the understanding of the skeletal morphology of these fossil Arachnida are due to confusion between the dorsal and ventral elements. It appears to me that in nearly all cases the dorsal surface is exposed; but that owing to the removal or crushing of the carapace the underlying coxæ and sternal area of the prosoma and the anterior sternal plates of the opisthosoma are also shown. The figures of the following species bear out this view: *Architarbus rotundatus*,[1] *Geraphrynus carbonarius*,[2] *Geratarbus lacoei*,[3] *Phalangiotarbus subovalis*.[4]

Judging from the figures published by Fritsch and Scudder of the species they name *Geraphrynus* (or *Architarbus*) *elongatus*, and from the material I have examined, I am convinced that in this group the

[1] Geol. Survey, Illinois, 1868, p. 568.
[2] Mem. Bost. Soc. Nat. Hist., vol. iv, pl. xl, figs. 1, 10, 12.
[3] Ibid., fig. 11.
[4] Geol. Mag., Vol. IX, p. 385, 1872 (*Ph.* '*Architarbus*' *subovalis*, H. Woodw.).

carapace is large, unsegmented, and has either a straight or convex or considerably produced posterior border; at least, the coxæ of the four posterior pairs of appendages are large and radiate from a central broader or narrower sternal area. The dorsal surface of the opisthosoma consists of five or six straight or curved but always short or very short anterior terga, and of three or four much longer posterior terga; and the ventral surface of seven, possibly eight, sternal plates, of which the posterior are long and the anterior short, the first being triangular and wedged between the coxæ of the last pair of legs.

The following notes on the genera above mentioned will explain my reasons for admitting them:—

1. In *Phalangiotarbus subovalis* the anterior five terga of the opisthosoma are short and straight, and the posterior three large, there being eight in all. The posterior border of the carapace is straight, the anterior border widely rounded. The chief peculiarities of the genus, however, lie in the facts that the sternal area of the prosoma is large and oval and that the coxæ of the legs of the first pair do not meet in the middle line beneath those of the palpi. Only one specimen of this genus has been discovered, and I judge of its character from the figure published by Dr. Woodward.

2. *Architarbus*, represented by the single species *rotundatus*, has the carapace rounded in front and strongly produced in the middle line behind, with the anterior terga of the opisthosoma curved round its bulging area. There are nine terga in the opisthosoma, and they appear to increase progressively in length from before backwards, the anterior five or six being short. The sternal area of the prosoma is small and subcircular, and round it radiate four pairs of coxæ of the ambulatory limbs, those of the first pair meeting in the middle line and concealing the basal segments of the palpi. This species is only known to me from Scudder's figure and description.

3. *Geraphrynus* has the carapace angular in front and convex or produced behind. The opisthosoma has nine terga, the posterior three being much longer than the anterior six, two or more of which follow the curvature of the carapace. The sternal area of the prosoma is long and narrow, and the coxæ of the legs of the first pair meet in the middle line and underlie those of the palpi, as in *Architarbus*. From the latter *Geraphrynus* seems to be separable by the anterior angulation of the carapace, the long and narrow sternal area of the opisthosoma, and the marked enlargement of the posterior three terga of the opisthosoma. When characterized in 1884 [1] this genus was based upon a single species represented by a specimen from Mazon Creek, Illinois. In 1890 the species was redescribed by Scudder,[2] several additional specimens being used for the purpose, but it is quite clear from the context that the example illustrated by fig. 10, pl. xl of the later work is the type. It is from the figure and description of this specimen and from examples of other species in my hands that the characters of the genus have been taken. Beyond recording my belief

[1] Proc. Amer. Acad. Arts & Sci., vol. xx, pp. 17–18.
[2] Mem. Bost. Soc. Nat. Hist., vol. iv, pp. 446–7.

that the other specimens described by Scudder as *G. carbonarius* were correctly referred to the genus *Geraphrynus*, despite the opinion of Hansen, I have nothing further to say about them. I cannot find any characters to justify the separation of *Hadrachne*, Melander,[1] from *Geraphrynus*.

4. *Geratarbus* was based upon two species, *G. scaber* and *G. lacoei*, which apparently belong to different orders of Arachnida, *G. scaber* being probably one of the Ricinulei. I select *G. lacoei*, therefore, as the type. Judging from the figure and description of *G. lacoei*, it seems that the posterior border of the carapace in *Geratarbus* is straight; the opisthosoma has nine terga, of which the anterior five are short and straight from side to side and the posterior four much longer, gradually increasing in length from the sixth to the ninth, the ninth equalling the sum of the seventh and eighth. The sternal area of the prosoma is narrow and elongate, and the coxæ of the first pair of legs meet only at their proximal ends and diverge at an acute angle. *Geratarbus* differs from *Geraphrynus* and *Architarbus* in the straightness of the posterior border of the carapace and of the anterior terga of the opisthosoma, in the difference in relative size of the posterior terga, and in the divergence of the anterior coxæ.

5. *Opiliotarbus*, nov. Carapace evenly rounded in front, its postero-lateral angles squared, and its posterior border straight. Opisthosoma nearly parallel-sided, somewhat widely rounded at its anal extremity, with apparently the normal number of sterna but only eight terga, of which the anterior five are short and straight and the posterior three very large. Sternal area of prosoma small, oval, longer than wide. Coxæ of legs of first pair in contact throughout. Type, *Architarbus elongatus*, Scudd.,[2] 1890, from Mazon Creek, Braidwood, Illinois.

Fritsch[3] published figures and descriptions of what he believed to be the dorsal and ventral views of Scudder's type of this species. So far as the dorsal surface is concerned this view is probably correct; but it is perfectly clear that the figure of the ventral side, if approximately accurately drawn, was taken from another specimen. I have no doubt that it represents a species of *Geraphrynus*. Neither in its proportions nor in the position of its limbs can it be made to agree with Emerton's figure of the ventral view of the type or with Fritsch's own figure of the dorsal view of the latter.

Opiliotarbus has the posterior border of the carapace and the anterior terga of the opisthosoma straight as in *Geratarbus*, but it differs from that genus in having only eight terga on the opisthosoma, of which five are short and three very long.

When the characters of the genera above described are analysed, it seems that *Phalangiotarbus* stands quite apart from the others in the large size of the sternal plate of the prosoma and the wide separation of the coxæ of the legs of the first pair. For this reason I propose to follow Haase and refer it to a distinct family, Phalangiotarbidæ. To comprise the rest the family name Architarbidæ is available.

In the following key to the genera I have juxtaposed them

[1] Journ. Geol. Chicago, vol. xi, p. 179, pl. v, fig. 1, and pl. vii, fig. 1, 1903.
[2] Mem. Bost. Soc. Nat. Hist., vol. iv, p. 449, pl. xl, fig. 1 (ventral view).
[3] Pal. Arachn., pp. 33, 34, fig. 37A (dorsal view), *not* fig. 37B.

according to my conception of their affinities based upon the figures and descriptions. If the latter are erroneous with respect to the distinctive particulars relied upon, *Opiliotarbus* and *Geraphrynus* will probably fall as synonyms of *Geratarbus* and *Architarbus* respectively.

a. Sternal area of prosoma elliptical and wide; coxæ of legs of first pair not meeting in the middle line beneath those of the palpi; opisthosoma with eight terga, the anterior five short and straight, the posterior three long.
Fam. PHALANGIOTARBIDÆ (*Phalangiotarbus*).
a'. Sternal area of prosoma quite narrow, generally linear; coxæ of legs of first pair meeting in the middle line beneath those of the palpi . Fam. ARCHITARBIDÆ.
b. Posterior border of the carapace straight; the anterior terga of the opisthosoma also straight.
c. Opisthosoma with only eight tergal plates, the sixth three times as long as the fifth and three times as wide as it is long . . . *Opiliotarbus*.
c'. Opisthosoma with nine tergal plates, the sixth twice as long as the fifth and five or six times as wide as it is long . . . . *Geratarbus*.
b'. Posterior border of the carapace evenly convex or considerably produced in the middle line; opisthosoma with nine tergal plates, of which at least the first and second are curved round the posterior border of the carapace.
d. Sternal area of the prosoma short and subcircular; terga of the opisthosoma progressively increasing in length from before backwards . *Architarbus*.
d'. Sternal area of the prosoma long and narrow; last three terga of the opisthosoma markedly longer than the others . . *Geraphrynus*.

VIII.—Note on the Discovery by Professor C. de la Torre of Fossil Mammals in Cuba.

By Dr. J. W. Spencer, M.A., B.A.C., etc.

At the recent meeting of the International Geological Congress in Stockholm, Professor C. de la Torre, of the University of Havana, made the announcement of a discovery of fossil mammals of Pleistocene age, in cavern deposits of Central Cuba. Hitherto the known fossil Vertebrates were few. Mr. T. W. Vaughan, in America, had published a long paper discrediting those previously reported, but before that time the late Professor E. D. Cope (America's great Vertebrate Palæontologist) had passed over the doubtful forms, and accepted especially one species of Edentate, supposing that other forms were buried and submerged during the subsequent depressions of the land.

Professor de la Torre's investigations have now established Cope's hypothesis that many other fossil mammals occur in Cuba. Some of the specimens, representing half a dozen species of Rodents, Edentates, and other forms, were shown at Stockholm, while others are at the Central Port Museum, New York, under Professor Osborn.

It may be added that the writer has also found the remains of *Amblyrhiza* (a Rodent as large as a deer) in a cavern on St. Martin, one of the north-eastern of the West Indian Islands—a notice of its occurrence in that island not having been published until the present time.

Apart from the palæontological interest, the value of this great discovery of fossils lies in its confirmation of the recent connexion of the islands with the continent, and the late high continental elevation as shown in the "Reconstruction of the Antillian Continent"

in 1895, previously reviewed in this Magazine. Similar evidence of great continental changes of level in Europe have been brought forward by Professor Edward Hull of this country, by Dr. Fridjof Nansen of Norway, and by others.

Professor de la Torre's investigations have also great interest in another field, for he has obtained a Jurassic fauna, which had been previously discovered, but later pronounced wanting in Cuba, by Mr. C. W. Hayes. Professor de la Torre is to be congratulated on his successful researches in geological problems of such great importance and of international interest which have a bearing on the question of cause of the Glacial period.

NOTICES OF MEMOIRS.

I.—British Association for the Advancement of Science. Sheffield, 1910. Address by the Rev. Professor T. G. Bonney, Sc.D., LL.D., F.R.S., President.

(*Concluded from the October Number, p.* 469.)

SUCH, then, are the facts, which call for an interpretation. More than one has been proposed; but it will be well, before discussing them, to arrive at some idea of the climate of these Islands during the colder part of the Glacial Epoch. Unless that were associated with very great changes in the distribution of sea and land in Northern and North-Western Europe, we may assume that neither the relative position of the isotherms nor the distribution of precipitation would be very materially altered. A general fall of temperature in the northern hemisphere might so weaken the warmer ocean current from the south-west that our coasts might be approached by a cold one from the opposite direction.[1] . . . I am doubtful whether we can attribute to changed currents a reduction in British temperatures of so much as 11°; but, if we did, this would amount to 28° from all causes, and give a temperature of 20° to 22° at sea-level in England during the coldest part of the Glacial Epoch. That is now found, roughly speaking, in Spitzbergen, which, since its mountains rise to much the same height, should give us a general idea of the condition of Britain in the olden time.

What would then be the state of Scandinavia? Its present temperature ranges on the west coast from about 45° in the south to 35° in the north. But this region must now be very much, possibly 1800 feet, lower than it was in pre-Glacial, perhaps also in part of Glacial, times. If we added 5° for this to the original 15°, and allowed so much as 18° for the diversion of the warm current, the temperature of Scandinavia would range from 7° to −3°, approximately that of Greenland northwards from Upernivik. But since the difference at the present day between Cape Farewell and Christiania (the one in an abnormally cold region, the other one correspondingly warm) is

[1] Facts relating to this subject will be found in *Climate and Time*, by J. Croll, 1875, chs. ii and iii. Of course the air currents would also be affected, and perhaps diminish precipitation as the latitude increased.

only 7°, that allowance seems much too large, while without it Scandinavia would correspond in temperature with some part of that country from south of Upernivik to north of Frederikshaab. But if Christiania were not colder than Jakobshavn is now, or Britain than Spitzbergen, we are precluded from comparisons with the coasts of Baffin Bay or Victoria Land.

Thus the ice-sheet from Scandinavia would probably be much greater than those generated in Britain. It would, however, find an obstacle to progress westwards, which cannot be ignored. If the bed of the North Sea became dry land, owing to a general rise of 600 feet, that would still be separated from Norway by a deep channel, extending from the Christiania Fjord round the coast northward. Even then this would be everywhere more than another 600 feet deep, and almost as wide as the Strait of Dover. The ice must cross this and afterwards be forced for more than 300 miles up a slope which, though gentle, would be in vertical height at least 600 feet. The task, if accomplished by thrust from behind, would be a heavy one, and, so far as I know, without a parallel at the present day; if the viscosity of the ice enabled it to flow, as has lately been urged,[1] we must be cautious in appealing to the great Antarctic barrier, because we now learn that more than half of it is only consolidated snow.[2] Moreover, if the ice floated across that channel, the thickness of the boulder-bearing layers would be diminished by melting (as in Ross's Barrier), and the more viscous the material the greater the tendency for these to be left behind by the overflow of the cleaner upper layers. If, however, the whole region became dry land, the Scandinavian glaciers would descend into a broad valley, considerably more than 1200 feet deep, which would afford them an easy path to the Arctic Ocean, so that only a lateral overflow, inconsiderable in volume, could spread itself over the western plateau.[3] An attempt to escape this difficulty has been made by assuming the existence of an independent centre of distribution for ice and boulders near the middle of the North Sea bed[4] (which would demand rather exceptional conditions of temperature and precipitation); but in such case either the Scandinavian ice would be fended off from England, or the boulders, prior to its advance, must have been dropped by floating ice on the neighbouring sea-floor.

If, then, our own country were but little better than Spitzbergen as a producer of ice, and Scandinavia only surpassed Southern Greenland in having a rather heavier snowfall, what interpretation may we give to the glacial phenomena of Britain? Three have been proposed. One asserts that throughout the Glacial Epoch the British Isles generally stood at a higher level, so that the ice which almost buried

[1] R. M. Deeley, Geol. Mag., 1909, p. 239.

[2] E. Shackleton, *The Heart of the Antarctic*, ii, 277.

[3] It has indeed been affirmed (Brögger, *Om de senglaciale og postglaciale niveaforandringer i Kristianiafeltet*, p. 682) that at the time of the great ice-sheet of Europe the sea-bottom must have been uplifted at least 8500 feet higher than at present. This may be a ready explanation of the occurrence of certain dead shells in deep water, but, unless extremely local, it would revolutionize the drainage system of Central Europe.

Geol. Mag., 1901, pp. 142, 187, 284, 332.

them flowed out on to the beds of the North and Irish Seas. The boulder-clays represent its moraines. The stratified sands and gravels were deposited in lakes formed by the rivers which were dammed up by ice-sheets.[1] A second interpretation recognizes the presence of glaciers in the mountain regions, but maintains that the land, at the outset rather above its present level, gradually sank beneath the sea, till the depth of water over the eastern coast of England was fully 500 feet, and over the western nearly 1400 feet, from which depression it slowly recovered. By any such submergence Great Britain and Ireland would be broken up into a cluster of hilly islands, between which the tide from an extended Atlantic would sweep eastwards twice a day, its currents running strong through the narrower sounds, while movements in the reverse direction at the ebb would be much less vigorous. The third interpretation, in some respects intermediate, was first advanced by the late Professor Carvill Lewis, who held that the peculiar boulder-clays and associated sands (such as those of East Anglia), which, as was then thought, were not found more than about 450 feet above the present sea-level, had been deposited in a great freshwater lake, held up by the ice-sheets already mentioned and by an isthmus, which at that time occupied the place of the Strait of Dover. Thus, these deposits, though directly due to land-ice, were actually fluviatile or lacustrine. But this interpretation need not detain us.

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Each of the other two hypotheses involves grave difficulties. That of great confluent ice-sheets creeping over the British lowlands demands, as has been intimated, climatal conditions which are scarcely possible, and makes it hard to explain the sands and gravels, sometimes with regular alternate bedding, but more generally indicative of strong current action, which occur at various elevations to over 1300 feet above sea-level, and seem too widespread to have been formed either beneath an ice-sheet or in lakes held up by one; for the latter, if of any size, would speedily check the velocity of influent streams.

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Some authorities, however, attribute such magnitude to the ice-sheets radiating from Scandinavia that they depict them, at the time of maximum extension, as not only traversing the North Sea bed and trespassing upon the coast of England, but also radiating southward to overwhelm Denmark and Holland, to invade Northern Germany and Poland, to obliterate Hanover, Berlin, and Warsaw, and to stop but little short of Dresden and Cracow, while burying Russia on the east to within no great distance of the Volga and on the south to the neighbourhood of Kief. Their presence, however, so far as I can ascertain, is inferred from evidence[2] very similar to that which we

[1] See Warren Upham, Monogr. U.S. Geol. Survey, xxv, 1896. This explanation commends itself to the majority of British geologists as an explanation of the noted parallel roads of Glenroy, but it is premature to speak of it as "conclusively shown" (Quart. Journ. Geol. Soc., vol. lviii, p. 473, 1902) until a fundamental difficulty which it presents has been discussed and removed.

[2] A valuable summary of it is given in *The Great Ice Age*, J. Geikie, chs. xxix, xxx, 1894.

have discussed in the British lowlands. That Scandinavia was at one time almost wholly buried beneath snow and ice is indubitable; it is equally so that at the outset the land stood above its present level, and that during the later stages of the Glacial Epoch parts, at any rate of Southern Norway, had sunk down to a maximum depth of 800 feet. In Germany, however, erratics are scattered over its plain and stranded on the slopes of the Harz and Riesengebirge up to about 1400 feet above sea-level. The glacial drifts of the lowlands sometimes contain dislodged masses of neighbouring rocks like those at Cromer, and we read of other indications of ice action. I must, however, observe that since the glacial deposits of Möen, Warnemünde, and Rügen often present not only close resemblances to those of our eastern counties but also very similar difficulties, it is not permissible to quote the one in support of the other, seeing that the origin of each is equally dubious. Given a sufficient 'head' of ice in northern regions, it might be possible to transfer the remains of organisms from the bed of the Irish Sea to Moel Tryfaen, Macclesfield, and Gloppa; but at the last-named, if not at the others, we must assume the existence of steadily alternating currents in the lakes in order to explain the corresponding bedding of the deposit. This, however, is not the only difficulty. The 'Irish Sea glacier' is supposed to have been composed of streams from Ireland, South-West Scotland, and the Lake District, of which the second furnished the dominant contingent; the first-named not producing any direct effect on the western coast of Great Britain, and the third being made to feel its inferiority and "shouldered in upon the mainland". But even if this ever happened, ought not the Welsh ice to have joined issue with the invaders a good many miles to the north of its own coast? Welsh boulders at any rate are common near the summit of Moel Tryfaen, and I have no hesitation in saying that the pebbles of riebeckite-rock, far from rare in its drifts, come from Mynydd Mawr, hardly half a league to the E.S.E., and not from Ailsa Crag.

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During the last few years, however, the lake-hypothesis of Carvill Lewis has been revived under a rather different form by some English advocates of land-ice. For instance, the former presence of ice-dammed lakes is supposed to be indicated in the upper parts of the Cleveland Hills by certain overflow channels. I may be allowed to observe that, though this view is the outcome of much acute observation and reasoning,[1] it is wholly dependent upon the ice-barriers already mentioned, and that if they dissolve before the dry light of sceptical criticism the lakes will "leave not a rack behind". I must also confess that to my eyes the so-called 'overflow channels' much more closely resemble the remnants of ancient valley-systems, formed by only moderately rapid rivers, which have been isolated by the trespass of younger and more energetic streams, and they suggest that the main features of this picturesque upland were developed before rather than after the beginning of the Glacial Epoch. I think that even 'Lake Pickering', though it has become an accepted fact with

[1] P. F. Kendall, Quart. Journ. Geol. Soc., vol. lviii, p. 471, 1902.

several geologists of high repute, can be more simply explained as a two-branched 'valley of strike', formed on the Kimeridge Clay, the eastern arm of which was beheaded, even in pre-Glacial times, by the sea. As to Lake Oxford,[1] I must confess myself still more sceptical.

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The submergence hypothesis assumes that, at the beginning of the Glacial Epoch, our Islands stood rather above their present level, and during it gradually subsided, on the west to a greater extent than on the east, till at last the movement was reversed, and they returned nearly to their former position. During most of this time glaciers came down to the sea from the more mountainous islands, and in winter an ice-foot formed upon the shore. This, on becoming detached, carried away boulders, beach pebbles, and finer detritus. Great quantities of the last also were swept by swollen streams into the estuaries and spread over the sea-bed by coast currents, settling down especially in the quiet depths of submerged valleys. Shore-ice in Arctic regions, as Colonel H. W. Feilden[2] has described, can striate stones and even the rock beneath it, and is able, on a subsiding area, gradually to push boulders up to a higher level. In fact, the state of the British region in those ages would not have been unlike that still existing near the coasts of the Barents and Kara Seas. Over the submerged region southward, and in some cases more or less eastward, currents would be prevalent; though changes of wind would often affect the drift of the floating ice-rafts. But though the submergence hypothesis is obviously free from the serious difficulties which have been indicated in discussing the other one, gives a simple explanation of the presence of marine organisms, and accords with what can be proved to have occurred in Norway, Waigatz Island, Novaia Zemlya, on the Lower St. Lawrence, in Grinnell Land, and elsewhere, it undoubtedly involves others. One of them—the absence of shore terraces, caves, or other sea marks—is perhaps hardly so grave as is often thought to be.

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But other difficulties are far more grave. The thickness of the Chalky Boulder-clay alone, as has been stated, not unfrequently exceeds 100 feet, and, though often much less, may have been reduced by denudation. This is an enormous amount to have been transported and distributed by floating ice. The materials also are not much more easily accounted for by this than by the other hypothesis. A continuous supply of well-worn chalk pebbles might indeed be kept up from a gradually rising or sinking beach, but it is difficult to see how, until the land had subsided for at least 200 feet, the Chalky Boulder-clay could be deposited in some of the East Anglian valleys or on the Leicestershire hills. That depression, however, would seriously diminish the area of exposed chalk in Lincolnshire and Yorkshire, and the double of it would almost drown that rock. Again, the East Anglian Boulder-clay, as we have said, frequently abounds in fragments and finer detritus from the Kimeridge and Oxford Clays.

[1] F. W. Harmer, Q.J.G.S., vol. lxii, p. 470, 1907.
[2] Q.J.G.S., vol. xxxiv, p. 556, 1878.

But a large part of their outcrop would disappear before the former submergence was completed. . . . The instances, also, of the transportation of boulders and smaller stones to higher levels, sometimes large in amount, as in the transference of 'brockram' from outcrops near the bed of the Eden Valley to the level of Stainmoor Gap, seem to be too numerous to be readily explained by the uplifting action of shore-ice in a subsiding area. Such a process is possible, but we should anticipate it would be rather exceptional.

Submergence also readily accounts for the above-named sands and gravels, but not quite so easily for their occurrence at such very different levels. . . . In other words, the sands and gravels, presumably (often certainly) mid-Glacial, mantle, like the Upper Boulder-clay, over great irregularities of the surface, and are sometimes found, as already stated, up to more than 1200 feet. Either of these deposits may have followed the sea-line upwards or downwards, but that explanation would almost compel us to suppose that the sand was deposited during the submergence and the upper clay during the emergence; so that, with the former material, the higher in position is the newer in time, and with the latter the reverse.

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The passing of the great Ice Age was not sudden, and glaciers may have lingered in our mountain regions when Palæolithic man hunted the mammoth in the valley of the Thames, or frequented the caves of Devon and Mendip. But of these times of transition before written history became possible, and of sundry interesting topics connected with the Ice Age itself—of its cause, date, and duration, whether it was persistent or interrupted by warmer episodes, and, if so, by what number, of how often it had already recurred in the history of the earth—I must, for obvious reasons, refrain from speaking, and content myself with having endeavoured to place before you the facts of which, in my opinion, we must take account in reconstructing the physical geography of Western Europe, and especially of our own country, during the Age of Ice.

Not unnaturally you will expect a decision in favour of one or the other litigant after this long summing up. But I can only say that, in regard to the British Isles, the difficulties in either hypothesis appear so great that, while I consider those in the 'land-ice' hypothesis to be the more serious, I cannot, as yet, declare the other one to be satisfactorily established, and I think we shall be wiser in working on in the hope of clearing up some of the perplexities. I may add that, for these purposes, regions like the northern coasts of Russia and Siberia appear to me more promising than those in closer proximity to the North or South Magnetic Poles. This may seem a "lame and impotent conclusion" to so long a disquisition, but there are stages in the development of a scientific idea when the best service we can do it is by attempting to separate facts from fancies, by demanding that difficulties should be frankly faced instead of being severely ignored, by insisting that the giving of a name cannot convert the imaginary into the real, and by remembering that if hypotheses yet on their trial are treated as axioms, the result will often bring disaster, like building

a tower on a foundation of sand. To scrutinize, rather than to advocate any hypothesis, has been my aim throughout this address, and, if my efforts have been to some extent successful, I trust to be forgiven, though I may have trespassed on your patience and disappointed a legitimate expectation.

II.—Index Generum et Specierum Animalium. Report of a Committee consisting of Dr. Henry Woodward (Chairman), Dr. F. A. Bather (Secretary), Dr. P. L. Sclater, Rev. T. R. R. Stebbing, Dr. W. E. Hoyle, Hon. Walter Rothschild, and Lord Walsingham.[1]

CONTINUOUS and steady progress has been made by Mr. Davies Sherborn in the preparation of Volume II of this Index. Since the report for last year was sent in, Mr. Sherborn has dealt with the remainder of the separate works of authors whose names begin with C, and of these the various editions of Cuvier proved exceptionally long and tedious to analyse. Other works have also been dealt with as opportunity offered.

Valuable assistance has been rendered by Mr. Hartley Durrant, who lent from Lord Walsingham's library (presented to the Trustees of the British Museum) a fine copy of the extremely rare work by Billberg, *Enumeratio Insectorum*, 1820, which has been indexed and made available for reference.

The slips, which are preserved in the British Museum (Natural History) by the kindness of the Trustees, are quite in order for those who wish to consult them, and are of exceptional value to anyone monographing a particular genus.

Mr. Sherborn and Mr. H. O. N. Shaw have written a paper clearing up the difficulties surrounding Sowerby's *Conchological Illustrations* and Gray's *Descriptive Catalogue of Shells*,[2] and Mr. Sherborn himself has written on the dates of the parts of Burmeister's *Genera Insectorum*, 1838–46.[3]

Systematic and regular work on this Index is greatly encouraged by the friendly attitude of the Association, and the Committee, in recommending its own reappointment, earnestly ask the Association to continue this valuable help by a further grant of £100.

III.—Outlines of the Geology of Northern Nigeria. By Dr. J. D. Falconer, M.A., F.G.S.[4]

THE Protectorate of Northern Nigeria lies for the most part between Lake Chad and the confluence of the Rivers Niger and Benue, and comprises an area of about 255,700 square miles. Crystalline rocks are exposed over about half of this area, and among them two series have been recognized: (1) a series of hard, banded, and much granitized gneisses of an Archæan type; (2) a series of quartzites,

[1] Read before the British Association Meeting, Sheffield, 1910 (Section D).
[2] Proc. Malac. Soc., September, 1909, pp. 331–40.
[3] Ann. Mag. Nat. Hist., January, 1910.
[4] Read before the British Association Meeting, Sheffield, 1910 (Section C).

phyllites, schists, and gneisses of sedimentary origin with associated amphibolites, hornblende schists, and other more or less metamorphosed igneous rocks. The two series, which were probably originally unconformable, have been folded together along axes which are predominantly meridional in direction. They have also been pierced by numerous igneous intrusions, which are readily subdivided into an older and a younger group. The older group consists principally of granites, wholly or partially foliated, which have been affected to a varying extent by the forces which produced the metamorphism of the gneisses and schists. The members of the younger group are non-foliated, and include such types as tourmaline granite, riebeckite granite, augite syenite, augite diorite, and numerous associated dyke rocks.

Rocks of Cretaceous age are found in the valleys of the Benue and the Gongola and in the angle between the two rivers. They are invariably gently folded and sometimes broken and faulted, and consist of a lower series of sandstones and grits, in part salt-bearing, and an upper series of limestones and shales, with numerous fossils of Turonian age. The post-Cretaceous rocks, which rest unconformably upon the Cretaceous Limestone, and are probably all of Eocene age, occur over three detached areas: (1) in Sokoto Province and the Niger Valley, (2) in Bauchi and Bornu, and (3) in Yola. The Sokoto Series, which contains marine intercalations yielding abundant Eocene fossils, is continuous southward with the sandstones, grits, and ironstones of the Niger Valley. The correlation of the sandstones, grits, and clays of Bauchi, Bornu, and Yola with the Eocene rocks of Sokoto and the Niger Valley is based partly upon lithological similarities and partly upon the absence of evidence of any extensive post-Eocene submergence of the Protectorate.

Extensive fields of basaltic lava occur in Southern Bornu and on the borders of Bauchi and Nassarawa; and numerous puys of trachyte, phonolite, olivine basalt, and nepheline basalt are distributed throughout Southern Bauchi, Muri, and Yola. The puys and lava-fields alike are the product of Tertiary volcanic activity.

During the latter part of the Tertiary period there appear to have been repeated minor oscillations of the crust, which culminated in the elevation of the Bauchi plateau and the Nassarawa tableland, the depression of the Chad area, and the establishment of the present river system.

IV.—The Occurrence of Marine Bands at Maltby. By Wm. H. Dyson.[1]

DURING the sinking operations at Maltby the writer has located the stratigraphical position of the fossils found and has inspected the excavated debris day by day. Although all fossils have been collected, reference is only here made to the marine bands.

Taking the top of the Barnsley Coal (2452 ft. 2 in. deep or

[1] Read before the British Association Meeting, Sheffield, 1910 (Section C).

2193 ft. 5 in. below Ordnance datum) as a base-line, the lowest marine band, 8 ft. 7 in. thick, occurred 340 ft. 1 in. above the Barnsley Coal, the section being 1 ft. 11 in. of bastard cannel overlain by 6 ft. 8 in. of blackish bind with balls of pyrites, and contained the following fossils, mostly preserved in pyrites: *Lingula mytiloides*, ? *Posidoniella*, *Pterinopecten carbonarius*, *P. papyraceus*, *Scaldia carbonaria*, *Euphemus urei*, *Macrocheilina* sp., *Glyphioceras* sp., *Cœlacanthus*, ? *Cheirodus*, *Megalichthys*, *Rhadinichthys monensis*, *Rhizodopsis sauroides*. Among these *Macrocheilina* was fairly abundant.

The next bed occurred 564 ft. 1 in. above the Barnsley Coal. The material was dark-blue bind with ironstone and small cank-balls, and the following forms were present: *Lingula mytiloides*, *Orbiculoidea nitida*, *Myalina compressa*, *Straparollus* sp., *Euphemus urei*, *Naticopsis* sp., *Pleuronautilus costatus*, *Solenocheilus cyclostoma*, *Acanthodes*, *Cladodus*, *Cœlacanthus*, *Megalichthys*, *Platysomus*, *Elonichthys* or *Acrolepis*, *Rhizodopsis*. Among these *Straparollus* is new to the Middle Coal-measures.

The next marine band, 20 ft. 0½ in. thick, lies 708 ft. 10½ in. above the Barnsley Coal, the section being 19 ft. 0½ in. of dark greyish-blue shale with hard cank-balls, resting on 12 inches of argillaceous limestone. It contains an abundant fauna, including twenty-six genera and thirty-five species of invertebrates, all marine forms. *Chonetes laguessiana*, *Lingula mytiloides*, *Orbiculoidea nitida*, *Productus anthrax*, *Ctenodonta lævirostris*, *Myalina compressa*, *Nucula æqualis*, *N. gibbosa*, *N. luciniformis*, *Nuculana acuta*, *Posidoniella lævis*, *P. sulcata*, *Pseudamusium anisotum*, *P. fibrillosum*, *Pterinopecten papyraceus*, *Scaldia carbonaria*, *Schizodus antiquus*, *Syncyclonema carboniferum*, *Euphemus d'orbignyi*, *E. urei*, *Loxonema acutum*, *L. ashtonense*, *L.* sp., *Rhaphistoma radians*, *Bellerophon* sp., ? *Dimorphoceras gilbertsoni*, *Ephippioceras clittellarium*, *Gastrioceras carbonarium*, ? *Glyphioceras paucilobum*, *G. phillipsi*, *G. reticulatum*, *G.* sp., *Orthoceras asciculare*, *O. sulcatum* = *koninckianum*, *O.* sp., *Pleuronautilus costatus*, *Acanthodes*, *Cœlacanthus*, *Elonichthys*, *Listracanthus*, *Megalichthys*, *Platysomus*, *Rhizodopsis sauroides*. Among these *Pseudamusium anisotum* has not hitherto been found above the Carboniferous Limestone. Among the fish-remains *Listracanthus* should be noted.

The highest bed occurs 1000 feet below the summit of the Middle Coal-measures and 1244½ feet above the Barnsley Coal. It is 10 ft. 11 in. thick, consisting of grey bind with ironstone bands, of greasy appearance. The fauna is poor, but Goniatites are not uncommon. *Lingula mytiloides*, *Orbiculoidea nitida*, *Myalina compressa*, *Nuculana acuta*, ? *Bellerophon* sp., *Glyphioceras phillipsi*, *G.* sp., *Orthoceras* sp., *Listracanthus*, *Megalichthys*, *Rhadinichthys monensis*. Among the fish-remains *Listracanthus* is to be recorded.

The writer is indebted to Dr. Wheelton Hind, F.G.S., and Dr. A. Smith Woodward, F.R.S., for examining and naming the fossils.

REVIEWS.

I.—Monograph of the Okapi—Atlas. By Sir E. Ray Lankester, K.C.B., M.A., D.Sc., F.R.S. Compiled with the assistance of W. G. Ridewood, D.Sc. 48 plates. 4to. Printed by order of the Trustees. Price 25*s*.

SINCE its discovery some ten years ago, the Okapi has perhaps been the subject of more papers and memoirs than have ever been devoted to any Ungulate mammal not of actual economic importance. The circumstances of its discovery, its isolation from other living forms, and its near relationship to *Palæotragus* and *Samotherium* of the Lower Pliocene of Greece have all excited general interest in it. An important addition to the publications referring to this animal has just been issued by the Trustees of the British Museum under the title *A Monograph of the Okapi—Atlas*. This volume consists of a series of forty-eight plates prepared under the direction of Sir E. Ray Lankester, in illustration of a complete account intended to be prepared by him. These illustrations are of especial value because they bring together figures of the skulls and skins of a considerable number of individuals, including not only those in the British Museum, but also several from foreign museums and private collections. One set of plates consists of a beautiful series of drawings of the skulls of a number of individuals, illustrating the great variability of this part of the skeleton and of the degree of ossification of the curious separate horn-cores or ossicones, which in one set of individuals are entirely absent. A number of other plates show some of the remarkable peculiarities in the structure of the vertebræ, particularly in the cervical region, and finally some ten plates are devoted to demonstrating the extreme variability of the striping on the fore and hind legs, and incidentally prove the futility of naming new species on the evidence of such unstable characters. It is much to be regretted that, according to the preface, the volume of text relating to these plates will probably not be published: at the same time the recent publication of several important memoirs on the subject renders this omission less serious, and the detailed and careful descriptions of the plates prepared by Dr. W. G. Ridewood add greatly to the value of the volume and go far to reconcile us to the absence of the text. The plates are for the most part drawn by Miss G. M. Woodward and Mr. Grönvald.

II.—Æolian Deposits.

[Alexandra Ivchenko's papers (in Russian, with abstract in French) will be found, illustrated, in Khrishtafovich's *Ezheiodnika no Gheol. i Min. Rossii* (*Ann. géol. et min. Russie*), xii, pp. 146–70, 1909.]

A GOOD deal has been written lately on Deserts in one form or another, and we think it may be interesting to give a résumé of the views of Alexandra Ivchenko (or as he transliterates his name into French, Iwtschenko) of Kiev. Mr. Ivchenko finds that the types

of stratification in æolian deposits can be divided into 'barkhans',[1] ripple-mark, diagonal with opposed dips, discordant parallelism with great differences in the dips, horizontal and vertical. These types occur both in sandy and dusty accumulations. One can observe in purely æolian deposits, strata due to insulation (limy, saline, or irony), to vegetation (earthy, clayey), or to wind; and these can be further subdivided. One can trace certain characteristics as one passes from the desert type of deposits to that of the edge of the desert and from that to the steppe. The loess of Turkestan is purely æolian, while that of Kiev is aquatic. Similarly, one can judge how different beds of other geological ages were formed; thus the red grits of Tartarian age were æolian, while the sands bordering the Dnieper were aquatic. It is necessary to distinguish the dusts of deserts formed from the denudation of local rocks from that formed from the denudation of the soils in depressions. In addition to ordinary winds the action of whirlwinds can often be distinguished by the spiral or circular arrangement of the dust particles. Whirlwinds, too, have a certain influence in the formation of desert depressions. Gentle breezes blowing towards ridges do not seem to have much influence in elevating dust unless the escarpment is below 30. Erosion and denudation of accumulations of dust upon low slopes seem to be localized and do not have a general influence. The dimensions of particles of desert dust transported by the wind diminish from the centre towards the margins of the desert: the dimensions of the dust of the soil, which are less mobile and less carried, diminish from the margins to the centre. The grains of sand have special characters in æolian and in aquatic deposits; in the former they are characteristically triangular. The vertical separation of accumulations of dust or sand can, up to a certain point, be attributed to the existence of vertical stratification. Similar beds due to the resistance of wind pressure may be in part the result of pressure of the upper beds on the lower beds of such deposits. The first (due to resistance to the pressure of the wind) form the surface of the accumulation, and the second (due to compression) form the interior.

III.—Brief Notices.

1. "Les Cavernes et les Rivières souterraines de la Belgique" is the title of a sumptuously illustrated work by E. van den Broeck, E. A. Martel, and E. Rahir, which has been published at Brussels in two volumes, 1910, illustrated by 26 plates and 435 text-figures. There is a total of 1857 pages, arranged in an extraordinary manner, as there are sundry interpolations independently paged in successive places in each volume, so that precise reference is rendered difficult.

The subject is dealt with in special relation to the hydrology of the Devonian and Carboniferous Limestones, and the question of potable waters.

The great purity of the Givetian Limestone in the Devonian and of the Upper Visean Limestone in the Carboniferous has facilitated the corrosive action of water and led to the production of some of the more

[1] Semicircular continental dunes.

important caverns and subterranean watercourses. These features are to some extent naturally dependent on tectonic structure, but all points are duly discussed—the folds and fractures, the mineral composition of the limestones and dolomites, the organic remains, notably of coral and crinoid, and the various kinds of weathering. The different forms of caverns and grottoes, the stalactites and stalagmites, tufa, swallow-holes, and underground channels are fully described; and the whole subject is illustrated by pictorial views and many charming vignettes, by diagrams, plans, geological maps, and geological sections. The living fauna and flora as well as Pleistocene and later organic remains receive attention, and there are abundant references to the literature.

2. The "Cenozoic Mammal Horizons of Western North America" are dealt with by Professor H. F. Osborn (Bulletin 361, U.S. Geol. Survey), and Mr. W. D. Matthew contributes an appendix comprising faunal lists of the Tertiary mammalia of the West. Various mammalian zones are recognized, from the *Polymastodon* zone of the basal Eocene to the *Equus* zone of the Pleistocene; and Professor Osborn concludes "that North America promises to give us a nearly complete and unbroken history of the Tertiary in certain ancient regions, which are, after all, comparatively restricted".

3. A "Description of New Carnivores from the Miocene of Western Nebraska" has been contributed by Mr. O. A. Peters to the Memoirs of the Carnegie Museum, Pittsburg, vol. iv, No. 5 (undated). The forms include species of *Daphænodon*, *Borocyon*, *Cynodesmus*, and *Tephrocyon*, belonging to the Canidæ; and *Paroligobunis*, belonging to the Mustelidæ.

4. We have received the first part of a work entitled "Geologische Charakterbilder", edited by Dr. H. Stille, and comprising six beautiful illustrations, with descriptions, by E. Philippi, of "Eisberge und Inlandeis in der Antarctis" (Berlin, 1910).

5. "Geology in relation to Civil Engineering," by Mr. Robert Boyle, Assoc.M.Inst.C.E., President of the Glasgow University Geological Society, has been published by John Smith & Co., Glasgow, price 1*s*. It is a small work of 19 quarto pages, and contains brief practical suggestions on the relation between geology and constructive works such as roads, railways, bridges, docks, etc., as well as on water-supply. As the author remarks, "Success or failure in an engineering scheme depends largely on geological conditions." General remarks are also given on geology, field-work, and the use of maps and sections; but it may be observed that it is not often that the geologist has to work out the true dip of strata by trigonometrical methods. The author devotes more space than appears necessary to igneous rocks and petrology, illustrating the subjects of road-metal, building-stone, etc., by microscopic sections. These are matters that few engineers can deal with personally, and the advice of a specialist should be sought when necessary.

6. Liverpool Geological Society.—In commemoration of the Jubilee of this Society, a small but interesting volume, *A Retrospect of*

Fifty Years' Existence and Work, has been prepared by a former President, Mr. W. Hewitt, B.Sc. (Liverpool, C. Tinling & Co., 1910, pp. 117). The Society was founded on December 13, 1859, at a meeting held at the residence of G. H. Morton. An excellent portrait of him is given, and there are portraits also of C. Ricketts, T. Mellard Reade, and Joseph Lomas, as well as illustrations of the footprints of *Cheirotherium* and of the gypsum boulder of Great Crosby. An account of the work accomplished by the Society, a list of papers published in the Proceedings, and biographical notices of some past members are included in the volume.

7. Cotteswold Naturalists' Field Club.—The first part of vol. xvii of the Proceedings of this Club is sumptuously illustrated with twenty-one plates and a number of text-figures. Geological articles dominate. Among these is a sketch of "Some Glacial Features in Wales and probably in the Cotteswold Hills", by Mr. L. Richardson, who gives an account of the prominent glacial phenomena in the region of Snowdon, and draws attention to glacial features in the Brecon Beacons and in the amphitheatral hollows of the Cotteswolds. The Rev. H. H. Winwood records a section of the White Lias (Upper Rhætic) at Saltford, near Bath. Mr. Richardson further contributes a detailed account of "The Inferior Oolite and Contiguous Deposits of the South Cotteswolds".

8. "The Volcanic Rocks of Victoria" formed the subject of the presidential address delivered by Professor E. W. Skeats in 1909 to Section C (Geology and Mineralogy) of the Australian Association for the Advancement of Science.

9. Geological Survey of the Transvaal.—"The Geology of the Country round Zeerust and Mafeking," by Mr. A. L. Hall and Dr. W. A. Humphrey, 1910, is the title of an explanation of Sheets 5 and 6 of the Survey Map of the Transvaal. The geological formations belong to the Dolomite and Pretoria Series, with intrusive and contemporaneous igneous rocks. The structure of the region, the drainage and water-supply, the Malmani goldfield, and the lead and zinc deposits of the Marico are described.

10. A Wealden *Anodonta*.—In 1856 Beckles referred to "*Anodon*(?)" in his paper "On the Lowest Strata of the Cliffs at Hastings" (Q.J.G.S., vol. xii, 1856, pp. 291, 292), a mixture of shells some of which are obviously Unios. Mr. R. B. Newton (Proc. Malac. Soc., vol. ix, June, 1910, pt. ii, p. 114) has now gone carefully into the subject and finds that an undoubted *Anodonta* does occur in the Wealden beds along with the various Unios so often met with. He figures and describes a beautiful specimen of the fossil, which he calls *A. Becklesi*, from the Fairlight Clays of Hastings. This forms part of the Rufford Collection now in the British Museum, and seems to be the oldest known true *Anodonta* yet described.

11. Geological Survey of Egypt.—A Report on "The Building Stones of Cairo Neighbourhood and Upper Egypt", by Dr. W. F. Hume, Director, is issued as *Survey Department Paper*, No. 16, 1910. It comprises full particulars of the white and yellow nummulitic

limestones that are quarried at Gebel Moqattam to the south-east of Cairo and elsewhere; some detailed quarry records are given on the authority of the late T. Barron, and a report on the chalky nummulitic limestones used as building stone in Upper Egypt is contributed by Mr. H. J. L. Beadnell. There are also notes on sand-lime bricks, portland cement, etc.

CORRESPONDENCE.

ORIGIN OF THE BRITISH TRIAS.

Sir,—In the October number of this Magazine Mr. A. R. Horwood has given us a summary of the conclusions he has come to as a result of his researches into the origin of the British Trias. The paper as printed, being only an abstract of a longer paper read at the British Association, has no doubt suffered much in clearness as a result of condensation. In its present form, however, it is unsatisfactory, being composed in part of facts long known and now put forward none too clearly and by no means for the first time, and in part of more or less new statements requiring substantiation. I feel, and I daresay I voice the feelings of other readers too, that I should now like to hear the evidence on which some of these last-mentioned statements are based. I do not wish for the present to be understood as criticizing the conclusions, but merely as asking for a more explicit statement of the facts. I will take the points under Mr. Horwood's own numbers.

(3) If there is a general absence of delta bedding in the Bunter [see (9)], what then is the evidence that it is a delta? Is it its dactyloid form (6), and, if so, is this capable of being demonstrated on a map?

(9) Apart from the fact that beds which should theoretically have lain at 40° now lie horizontal, is there any other evidence of tilting through an angle of 45° in any part of the Trias?

(16) I am not very clear as to the author's meaning here, but I presume it is that the signs of wind erosion are confined to one level on the syenites and other older rocks. I would now ask how many cases of this wind erosion are known and to what extent they can be demonstrated to occur only at one horizon in the marls; also whether the opportunities for their observation are not very exceptional?

(20) What is the evidence that the supposed Bunter river came from North-West Scotland? I am aware that I may be displaying great ignorance of the literature of the subject in asking this question, but in that case a reference will set me right.

(21) What are the points of petrographical correspondence between the Bunter, Keuper, and modern delta formations? What bearing on this question has the immediately following statement that "the Leicestershire Trias shows signs of chemical action, the Nile delta of mechanical"?

W. B. Wright.

Dublin.

POLLICIPES FROM THE TRIMMINGHAM CHALK: A CORRECTION.

In the GEOLOGICAL MAGAZINE for August, 1906, I described a number of species of Cirripedes mostly from the Norfolk coast. Amongst these I recorded and figured two valves from Mr. Brydone's Collection (op. cit., p. 348) under the name of *Pollicipes concinna*. The specific name *P. concinnus* was used by Darwin more than fifty years previously in his Monograph on the fossil Lepadidæ (Pal. Soc., 1851, p. 50, pl. iii, fig. 1) for an Oxford Clay species. I regret my carelessness, and apologize for having neglected to correct it earlier.

I now propose to designate these specimens from the Trimmingham Chalk Bluff as *Pollicipes corrugatus*.

HENRY WOODWARD.

OBITUARY.

JOHN WILLIS CLARK, M.A., F.S.A.

BORN JUNE 24, 1833. DIED OCTOBER 10, 1910.

WE regret to record the death of Mr. J. W. Clark, Registrar of the University of Cambridge, and formerly Superintendent of the University Museum of Zoology and Comparative Anatomy. A versatile man who rendered distinguished service to Art, Literature, and Science, Mr. Clark was endowed with a personality that brought him many friends. To geologists he was known as chief author (with Professor T. McKenny Hughes) of the fascinating *Life and Letters of the Reverend Adam Sedgwick* (2 vols., 1890); and as he remarked in the preface, "No task could have been more congenial to me."

MISCELLANEOUS.

NORWICH CASTLE MUSEUM: NEW CURATOR APPOINTED.—In March last (GEOL. MAG., pp. 141–3) we noticed this excellent Museum and made special reference to its Curator, Mr. James Reeve, F.G.S., who had held office for more than fifty years, and sought retirement. Mr. Reeve was appointed "Consulting Curator of the Museum", and the salary of Mr. Frank Leney, the Assistant Curator, was raised, but the post of Curator was not filled up at that time. On September 21 the Council met under the presidency of the Lord Mayor, who moved that, as recommended by the Castle Museum Committee, Mr. Frank Leney, the present Assistant Curator, be appointed Curator, at an annual salary of £250. The Lord Mayor, who was seconded by Mr. Wild, said the Committee were unanimous in this recommendation. Mr. Leney had held the post of Assistant Curator for ten years, and they were all agreed that it was for the benefit of the city and of the museum that the appointment should be made. The motion was then carried *nem. con.*